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PREFACE

On May 17 and 18, 1958, the Editorial Committee met at the Annual Reviews Building in Palo Alto to attempt long-range planning in the hope that a more adequate topical arrangement of *Annual Review* chapters might eventuate. Because of the time lag between the selection of the authors and the publication of their chapters, the effects of this planning are only now becoming visible. In presenting the results of the Committee's deliberations, it should be stressed that no rigid pattern was sought but rather a listing of topics and subtopics which would be kept or scrapped in light of the experiences of later Editorial Committees and the wishes of readers. As developed, the scheme envisages offering certain chapters every year (designated by 1's), other chapters on alternate years (2's), still others every third or fourth year, and a few only occasionally (x's). For example, by appropriate selection and scheduling of two chapters annually the entire field of Learning and Motivation could be covered every three years. Such a procedure would, in effect, result in a more systematic treatment of an aspect of learning periodically rather than a potpourri of the entire field annually.

MASTER PLAN

<i>Developmental</i>	1	Theory and Techniques of Assessment.....	x
<i>Learning and Motivation</i>		<i>Physiological Psychology</i>	
Emotional Aspects of Learning...	3	Brain Functions.....	2
Learning Theory.....	3	Electrophysiology and Behavior...	4
Motor Skills.....	3	Psychopharmacology.....	4
Neurophysiology of Learning.....	3	<i>Social Psychology</i>	
Perceptual Learning.....	3	Attitudes and Opinions.....	3
Psychophysiology of Motivation..	3	Group Dynamics.....	3
<i>Comparative Psychology and Ethology</i>	1 or 2	Mass Communication.....	3
<i>Receptor Processes</i>		Psychology and Culture.....	x
Audition.....	1	Value Theory and Behavioral Decision.....	x
Perception.....	2	<i>Industrial Psychology</i>	
Chemical Senses.....	4	Personnel Management.....	2
Somesthetic Senses.....	4	Personnel Selection.....	2
Vision		Consumer Analysis (Market Research).....	3
Color.....	3	Engineering Psychology (Human Engineering).....	3
Spatial Vision*.....	3	Industrial Relations.....	3
Visual Sensitivity*.....	3		
<i>Personality</i>			
Personality Dynamics.....	2		
Personality Structure.....	2		

* Spatial Vision includes minimum separable and minimum visible acuity, object recognition, legibility of type, and the more applied material of the conditions of seeing (including relevant physiological studies). Visual Sensitivity includes luminosity functions, dark and light adaptation, brightness discrimination, and flicker discrimination (as well as the physiological work relevant to these functions).

Proc. Pub., 2-16-60

<i>Statistics</i>		Psychological Deficit.....	4
Scaling and Test Theory.....	2	<i>Ungrouped</i>	
Statistical Theory.....	2	Aesthetics.....	x
<i>Abnormal and Clinical Psychology</i>		Cognitive Functions (Problem	
Psychotherapeutic Processes.....	1	Solving, Concept Formation	
Classification of Behavior Dis-		etc.).....	x
orders.....	4	Educational Psychology.....	x
Physiological Bases of Abnormal		Genetics of Behavior.....	x
Behavior.....	4	Gerontology.....	x
Projective Methodologies.....	4	Psycholinguistics.....	x

In line with the "master plan," Learning of Volume 10 becomes Perceptual Learning in Volume 11; Vision is replaced by Color Vision; and Personality by Personality Dynamics. Psycholinguistics, Psychopharmacology, and The Genetics of Behavior appear as new topics, while Engineering Psychology and Psychological Aspects of Aging (Gerontology) make reappearances. Educational Psychology does not appear as a chapter caption in the current volume nor do Problem Solving and Thinking, Motivation, Theory and Techniques of Assessment, or Hearing. There is no chapter on Psychology in the U.S.S.R., but such a title will probably appear next year.

It will be noted that the style of Volume 11's bibliography looks somewhat more "APA-ish." Also to be noted are the cumulative indexes of chapter authors and subjects that appear on the terminal pages of the volume, another new feature. In this volume will be found a complete list of the chapter headings and authors from the initial book up to and including the present volume. In keeping with a new policy for Annual Reviews, Inc., these cumulative chapter indexes will appear each year, embracing the last five volumes of the series, including the volume in which the cumulative index appears. Still another innovation begins this year. Because of an organizational change in the editorial office of Annual Reviews, Inc., the *Annual Review of Psychology* will henceforth be published in February instead of January.

The Editorial Committee regrets that J. M. Butler's term of office ended January 1, 1960, but welcomes to its membership Harold Schlosberg, whose service began in 1959. It is a pleasure to be able to announce the appointment by Annual Reviews, Inc. of Olga McNemar, a most capable experimental psychologist, as a second Associate Editor. Her term, which started January 1, 1960, will parallel that of the Committee's Chairman, Paul R. Farnsworth, who has been reappointed for another term as Editor. During the year Miss Marian Hays served as Editorial Assistant, and the Misses Dorothea and Sheila Ross compiled the subject index. The editors deeply appreciate their services. Attention is called to the fact that it is the Editorial Committee of 1957 (listed on page ii) whose members should receive credit for the selection of the chapter authors of this volume.

J.M.B.	L.G.H.
D.B.H.	Q.McN.
J.McV.H.	H.S.
P.R.F.	

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ANNUAL REVIEW OF PSYCHOLOGY
VOLUME 12 (1961)

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CHEMICAL SENSES, *L. Beidler*
BRAIN FUNCTIONS, *K. L. Chow*
BEHAVIORAL DECISION THEORY, *W. D. Edwards*
EMOTIONAL ASPECTS OF LEARNING, *F. W. Irwin*
CONCEPT FORMATION, *T. S. Kendler*
CLASSIFICATION OF BEHAVIOR DISORDERS, *M. Lorr*
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VISUAL SENSITIVITY, *C. G. Mueller*
AUDITION, *I. Pollack*
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A REVIEW OF THEORY IN PHYSIOLOGICAL PSYCHOLOGY¹

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INTRODUCTION

The impact of recent technical advances on the subject matter of neurophysiology and neuropsychology is not limited to the accumulation of data. Ways of looking at the functions of the central nervous system in behavior keep pace with the detail of facts. Neuropsychological data were extensively reviewed in these volumes only last year (130); data from the adjacent fields of sensory psychology (61, 68, 127), psychochemistry, and psychopharmacology (98, 124, 154) are covered in several sources. But no recent review of "theory" in physiological psychology is readily available. Thus, this fascinating, though difficult, topic is chosen for discussion. In keeping with the policy of the *Annual Review of Psychology*, a considerable degree of selectivity in acceptance and rejection of material for review has been exercised; and several outright speculations that reveal the author's biases are included.

BASIC FUNCTIONS OF CENTRAL NEURONAL AGGREGATES

During the first half of this century the predominant view of neuronal aggregates, or "brains," has been that they constitute essentially passive, inert masses of specialized tissue sensitive to excitations propagated to and from them by nerve trunks. Alterations in patterns of excitation between input and output were conceived to be the result of stable and specific geometrical configurations of connections established, for the most part, as a result of experience. This view was developed into what has become neuron and reflex-arc theory as expressed, for instance, in Sherrington's lectures published under the title, *The Integrative Action of the Nervous System* (136). However, the spatial, geometrical pattern of connections was never conceived as the only explanatory principle in reflex-arc theory; even at the relatively simple level of complexity of the interaction of spinal reflexes Sherrington invoked the concepts of central excitatory and inhibitory states and of simultaneous and successive spinal induction. These properties of the reflex arc were attributed to presumed discontinuities between neural elements—the synapses. Studies of synaptic processes proceeded, but, in their effect on behavior theory, they were overshadowed by the less elusive all-or-none properties of neural tissue—those involved in impulse transmission. Gradually, however, synaptic processes and their counterparts in axons

¹ The author wishes to express gratitude to Jane Connors for suggesting the topic for this review and for providing the cutting edge to penetrate the enigma that surrounded reinforcement; to George Miller and Eugene Galanter, fellow conspirators in the task of putting some flesh and blood into simulation psychology and some active complexities into the brains of behavioral neurophysiologists; to Elizabeth Connor and Muriel Bagshaw for their interested help in preparing the manuscript.

(electrotonic phenomena) and dendrites (dendritic potentials) have pre-empted attention; today any realistic view of the functions of central neuronal aggregates must take these data into account. In addition, a considerable amount has been learned about the background of the neural activities into which any environmental stimulus must intrude in order to be effective.

INTRINSIC RHYTHMS

A series of carefully controlled studies from the Burns laboratory (23) has contributed some definitive answers to an age-old question: What happens when brain tissue is completely isolated neurally from other nervous tissue? The answers are, as they so often are, neither completely supportive of the notion that central activity is basically "spontaneous" nor entirely supportive of the axiom of a *tabula rasa*. Burns found that, even in the unanesthetized animal, the isolated cortical slab remains quiescent unless stimulated, although there are some other reports (39, 48, 65, 69, 88) that indicate that spontaneous activity may be present occasionally and temporarily. In any case, a few strong electrical stimuli applied to the cortical surface will produce a series of bursts of neural activity which usually continue for many minutes after stimulation has stopped. If a series of 10 such stimuli are given at intervals of three seconds each, neurons continue to discharge throughout the slab for as long as an hour.

The periodic waves of excitation that follow a few infrequent stimuli given to the unanesthetized cerebral cortex are also found to occur whenever diffusely organized nervous tissue is stimulated. Long-lasting effects have been observed after brief stimulation in the intact sea anemone—effects lasting many hours (11). Recently the luminescence response of sea pansies (a colorful soft coral) has been described as follows. After a series of stimulations, these colonies begin to luminesce spontaneously instead of doing so only in response to stimulation (22). To explain this behavior, a slow change of state in the neural tissue (a form of memory process?) must be invoked. These changes of state are accessible to environmental influence and are, of course, influenced by the previous activity of the organism, but they have intrinsic properties and their own time course of activity that determine recurrence apart from the environment of the moment.

In short, neuronal aggregates of the type found in the cerebral cortex are quiescent in the absence of continuous input. However, these aggregates are easily aroused to prolonged activity. Hence, at "rest," they may be conceived to be just below the excitatory level for continuous self-excitation. In the intact mammal, a mechanism exists to insure excitation beyond such a resting level. This mechanism is the spontaneous discharge of receptors.

Granit (55) has detailed how, gradually, "the idea of spontaneous activity as an integral part of the performance of sensory instruments has grown upon us." He traces the history of the subject from the early observations of Adrian & Zotterman (4) and of Adrian & Matthews (2, 3) on muscle and on optic nerve preparations to his own extensive experimental analyses. In addition, he cites evidence to support the suggestion that this "spontaneous activity of sense organs makes them one of the brain's most important 'ener-

gizers' " or activators. Granit posits that the nonmodality-specific reticular systems of the neuraxis, which receive branches from various sensory afferents in their passage upward, are the locus of the activating mechanism.

THE FEEDBACK UNIT—AN ALTERNATIVE TO THE S-R REFLEX ARC

The description of the dependencies between central neuronal aggregates and receptor activities is incomplete, however, if the relation is considered only as strictly one-way traffic. Livingston (91) and Granit (55) have thoroughly reviewed the large body of evidence that receptor activities are under efferent control from the central nervous system. With respect to muscle spindles, one-third of the efferents in the ventral spinal root serve this function (84, 85). In the optic and otic systems (45, 54), experiment has shown that the afferent activity originating in the receptors can be directly modified by central nervous system excitation. These facts make it difficult to maintain any longer the uncomplicated view of the functions of the central nervous system in behavior that are based on the simple S-R reflex arc. Bruner (21) has suggested some of the ways that psychology could be enriched by taking into account these new data. It is worthwhile, therefore, to re-examine for a moment the concept of the reflex arc and to see whether a useful alternative to this war horse can be found.

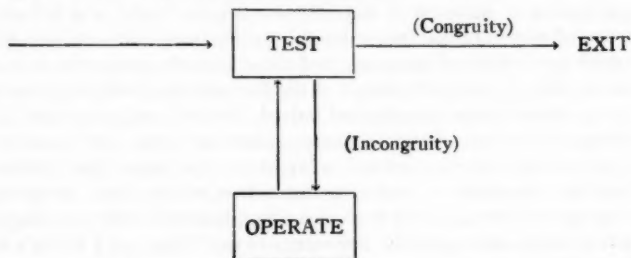
Sherrington, more than anyone else, is responsible for the popular conception of the reflex arc. Yet Sherrington (136), more than any one else, cautions again and again against oversimplification: "The simple reflex arc is a useful fiction"—used by Sherrington to explain the behavior of the spinal preparation. The most quoted example of the "simple" reflex is, of course, the stretch reflex, e.g., the knee jerk. Sherrington expressly states that he does not conceive this reflex to be an example of his "simple" reflex. Indeed he questions whether the stretch mechanism is a reflex at all. The reflex arc was invented by him to explain the difference between the observed properties of nerve trunks and the properties that had to be inferred to describe the neural tissue that intervenes between receptor stimulation and effector response. Nerve trunks transmit in either direction; characteristically, signals are of the all-or-none type. Reflex action, on the other hand, is unidirectional and is characterized by graded response. Sherrington explained the differences by espousing the neurone doctrine. This doctrine proposes that the nervous system is made up of discrete neural units (cells) which have the properties of nerve trunks; intercalated between these units are discontinuities which he christened synapses, and these have the properties unique to reflexes. In Sherrington's discussion of the interaction of reflexes, these synaptic properties become complicated indeed. Central excitatory and inhibitory states, simultaneous and successive spinal induction, and convergence and divergence of pathways are only a few of the most important intervening variables he postulated to explain reflex action of the spinal preparation. These properties are a far cry from the ubiquitous S-R reflex-arc diagrams that grace (more appropriately, one wants to say "disgrace") today's texts.

The evidence that receptors are under efferent control from the central nervous system makes possible a revision of the reflex-arc concept that is at

the same time more in keeping with the data and is definitely in keeping with the richly flexible nervous system that the psychologist needs if he is to have any useful conception of what goes on in the central nervous system during behavior. Since World War II, communications and control engineers have publicized the utility of a device that "feeds back" to a sensing mechanism the results of the actions of the machine of which the sensing mechanism is a part. This device is called the simple servomechanism, and neurophysiologists were quick to see that many of the processes that they had been studying in the central nervous system have the properties of simple servos (33). In fact, the central regulation of receptor activities makes it necessary to conceive of even the simplest reflex mechanisms in these terms.

What are the essential differences for psychology between the S-R reflex-arc concept and the simple servomechanism concept? Most important is a shift in emphasis. The shift is from the notion that an organism is a relatively passive protoplasmic mass whose responses are controlled by the arrangement of environmental stimuli to a conception of an organism that has considerable control over what will constitute stimulation. This control is exercised both through regulation by central processes and through a double feedback to receptors from response through environment and through the nervous system. Anyone who has spent any effort on the intricacies of "shaping" an animal or human preparatory to an operant conditioning experiment should sympathize with the validity of this shift in emphasis.

In detail, then, the alternative to the simple S-R notion of the reflex arc is a double mechanism that is constituted of one neuronal aggregate that is sensitive to a variety of inputs and another aggregate that is reciprocally connected to the first and effects the changes initiated by the first. Peripherally, the sensing mechanism includes the receptor; the effecting mechanism, the muscles and the glands. Miller, Galanter & Pribram (101), among others, have developed in detail the idea that the essential characteristic of the sensing mechanism is to test for incongruities and that the essential characteristic of the effecting mechanism is to operate on other units (that may include the environment) so as to decrease incongruity in the sensing mechanism. They speak of this sequence as Test-Operate-Test-Exit (TOTE) and suggest that this, rather than the S-R reflex arc, is the basic unit that controls action. A diagram of the simple feedback unit looks like this:



GRADED-RESPONSE MECHANISMS

In the S-R reflex-arc conception of the control of action, the importance for psychology of graded response mechanisms was confined pretty largely to the synapse. How are graded responses treated today? Bishop (15), in a definitive review that discusses the "natural history of the nerve impulse," states that "the chief and most characteristic functions of neurons and other excitable tissues are performed by means of graded responses." He suggests that graded responses are "more general as well as more primitive than the all-or-none response and that the latter probably developed when an early metazoan became too large. . . ." The author reviews the evidence supporting the contention that the cerebral cortex "still operates largely by means of connections characteristic of primitive neuropil, the most appropriate mechanism for the maintenance of a continuous or steady state, as contrasted to the transmission of information about such states." The dendrites, rather than the "impulsive axon," are probably the essential elements of graded response tissue. Axonic transmission of nerve impulses is conceived to transmit information about the continuous, steady state of excitability maintained by graded response tissue.

Upon what evidence do these heretical views rest? Should the "all-or-none" law be modified in favor of an "all-or-something" law? That graded response mechanisms exist in neural tissue is not news, of course. Electrotonic potentials and synaptic potentials have been studied for some time. The importance of graded dendritic potentials is news, however. The discovery came about in the following way. Li, Cullen & Jasper (87) and Bishop & Clare (16) were making use of the newly discovered microelectrode technique to investigate an important problem: How are the potential changes observed by means of the electroencephalogram generated? The common notion was that the recorded changes reflected some envelope of the impulsive activity of neural elements. The results of the studies indicated that such was not the case: the changes recorded by the electroencephalogram or electrocorticogram show a variation which is relatively independent of the number of impulses generated by the neurons sampled at the site of recording. And when recordings are made from the separate layers of the cortex, the potential changes that correlate with the electroencephalogram are those that are obtained from layers rich in dendrites. Investigations in this area are so recent (146) that very little is yet definitely known of the functional significance for behavior of these graded response mechanisms of neural tissue. Nor are the impulsive aspects of neuronal activity to be ignored—but theories about these will be dealt with in the last section of the review. In this context, one cannot but call to mind the pioneer work of Barron & Matthews (10), of Gerard & Libet (47), and of Skoglund (139), who showed that neuronal aggregates are sensitive to graded (direct current) electrical stimulation and that this sensitivity is differential with respect to polarity and the like. Köhler (83) has recently reviewed these experiments and those performed under his direction, and has used these data to develop his field notions of

neural action in perception. Could it be that the sensitivities to graded stimulation and the graded response mechanisms are the characteristics essential to the test phase that goes on within the neuronal aggregates that serve as the simpler TOTE units?

In summary, then, some very old questions have received limited but definitive answers. The brain, though in some ideally abstract way quiescent unless stimulated, becomes intrinsically active for prolonged periods after even momentary excitation. That this excitation is provided by the afferent connections from receptors is not surprising; what is new is the finding that receptors are spontaneously active even in the absence of stimulation from the environment. Furthermore, the spontaneous receptor activity is not only influenced by environmental events but is also under centrifugal control from the central nervous system. These facts make it necessary to replace the simple S-R reflex-arc concept. The notion of the simple servomechanisms, borrowed from communications and control engineering, is the most logical and useful replacement. The servo is conceived to act as a Test-Operate-Test-Exit (TOTE) sequence accomplished by two reciprocally connected neuronal aggregates. One of the aggregates performs the test functions; when incongruities of inputs occur in the test, control is shifted to another neuronal aggregate that operates on other neural mechanisms or on the environment, or on both, until the incongruities of the test are resolved. Graded response mechanisms, originally attributed primarily to synapses, have been found to be an important characteristic of all central neural tissue. These graded response mechanisms may play an essential role in the test phase of the simpler TOTE sequences.

FUNCTIONAL LOCALIZATION IN THE CENTRAL NERVOUS SYSTEM

THE CONCENTRIC NERVOUS SYSTEM

During the past decade there has been an important change in the way in which experimentalists have approached the analysis of the central nervous system. Earlier studies had, for the most part, supplied horizontal divisions: the spinal animal, the *encéphale isolé*, the decerebrate and decorticate preparations. Such laws as "progressive encephalization" of functions during phylogenesis and the "control of lower neural levels by higher ones" resulted from these studies.

More recently, analysis has become vertical. At the mesencephalic level, the Magoun group (97) has focused on the differences in organization and function of the reticular core, on the one hand, and the classical relay mechanisms of the more external portions, on the other. At the diencephalic level, Jasper (73) and his group have concentrated on clarifying the functions of the midline and intralaminar systems of the thalamus, functions that were initially described by Dempsey, Morison & Morison (34) and others. Several groups of investigators converged on the hypothalamus, another midline

diencephalic group of structures, to demonstrate some similarity of function between it and the mesencephalic and dorsal thalamic mechanisms. Finally, a group of investigators, sparked by Fulton (44), followed up the findings of Klüver & Bucy (82) and of Bard & Mountcastle (9) to differentiate the functions of the medial and basal "limbic" formations of the forebrain from those of the more laterally located portions of the cerebral mantle. These analyses have provided a conception of a nervous system built "from the inside out"—and some new laws can be stated that describe the properties of this concentric nervous system.

The internal core of the brain stem: biased homeostats and theories of drive.—Over a century ago, Bernard (13) initiated a branch of neurophysiology that is concerned with the regulation of the organism's metabolism and endocrine functions by the central nervous system. These now famous "picure" experiments, in which diabetes was produced by making small stab wounds in the brain stem, led Bernard to the conception of a *milieu intérieur* that is still central in the thinking of modern neurophysiologists [e.g., the reviews by Colle, Gasteaut & Dell (32)]. Somewhat less well known are the extensive series of experiments by Karplus (76) and Karplus & Kreidl (77, 78, 79) performed at the beginning of the century. These experiments thoroughly explored the relations between diencephalic centers and the regulation of visceral activities. More recently, this branch of neurophysiology has been advanced by Cannon's (25) formulation of the concept of homeostasis and by the laboratory analyses that occupied him and his collaborators. Another group of experimentalists, directed by Ranson (125), explored the relations between hypothalamic mechanisms and the maintenance of body temperature and food intake and activity. Contemporary investigations of the thirst mechanisms (60), of endocrine control (60, 66), and of respiratory regulation by the partial pressure of CO_2 in the brain-stem respiratory center (100) are only some of the highlights in this area of investigation.

In spite of the variety of arguments against the notion, these experimental results have tended to confirm the idea that specific centers exist in the central nervous system to control one or another of the metabolic and endocrine activities of the organism. Most of the evidence against centers has come from studies that deal with parts of the central nervous system other than these centrally located regions in the brain stem and with behavior other than that involved in the regulation of the organism's metabolism. What, then, characterizes these structures; what makes them different from other central neuronal aggregates? The most useful way to look at this difference seems to revolve around the specific sensitivities of these centers to one or another physicochemical substance. And this is exactly how receptors are defined in the peripheral nervous system.

The conception that receptor mechanisms may be located around the midline ventricles of the brain stem derives support from two sources. The experiments already alluded to have produced data that are consistent with the concept of homeostasis. Any homeostat must include an element that is

especially sensitive to the range of physical (or chemical) events that the homeostat attempts to regulate. In the case of the brain-stem homeostats, this sensitive element could be entirely located in the peripheral mechanism that is apparently connected with the central nervous system, but experiment has demonstrated that at least some of the sensitivity is located centrally, e.g., hypertonic saline injected into the third ventricle immediately causes goats to drink voluminously (6); heat applied to the base of the anterior extremity of the third ventricle immediately causes changes in the heat regulating mechanisms all over the body (125); very local changes in the partial pressure of CO_2 in the posterior brain stem dramatically alter the rate and depth of respiration (100). All of these sensitivities are specific and restricted to very small regions, and all are localized to structures fairly near the third and fourth ventricles of the brain stem.

The second source of support for the conception that receptor mechanisms might be located near the midline ventricular system is less direct. Ontogenetically, this median part of the central nervous system is derived from the most dorsal part of the neural crest: invagination to form the neural tube makes the periventricular components those most akin in origin to the epidermal portions of the ectodermal formations. And it is these portions of the ectoderm that induce some of the more specialized of the receptors, such as the retina. Furthermore, the sensitivities of the periventricular mechanisms are very similar to those of the skin. Temperature change, deformation, and changes in hydration are some of the major categories of stimuli to which both are sensitive.

In summary, then, the work of a century of neurophysiological experiment seems to be leading to the conception that a series of specialized receptors are located near the midline ventricular systems of the brain stem. These specialized receptors are the classical centers for the control of respiration, food intake, etc., that have interested physiologists and biochemists concerned with the neural regulation of the organism's metabolism and endocrine functions. These receptors are conceived to function as sensitive elements of a variety of homeostats concerned with the regulation of appetitive-consummatory processes.

Immediately beyond the limits of the periventricular receptor centers lies a matrix of neural reticulum spotted here and there with neuronal aggregates and coursed only occasionally by long nerve fibers. The anatomy of the brain stem reticular formation has been detailed by Brodal (20), and by the Scheibels (132); its physiology is well documented in a recent symposium (126) and by Magoun (97) in his Salmon lecture. Characteristically, the reticular systems are composed of fairly short, fine-fibered neurons with vast dendritic networks. Inputs converge on each nerve cell from many branches of the long classical projection tracts that originate in the various receptor fields of the organism. Each neural element in the system is influenced by a variety of sensory modes indicated by changes in the electrical activity as recorded with microelectrodes. In addition, a reciprocal relation with the

rest of the neuraxis exists, e.g., the cerebral cortex is activated when the brain-stem reticular formation is electrically excited and, conversely, cortical stimulation affects the activity of the reticular systems. This convergence of input and diffuseness of interrelations suggests that the most likely action of these systems is to influence the general state of excitability of the nervous system. This suggestion is supported by the finding that cortical rhythms are activated and deactivated by electrical stimulation of the reticular formation and by the fact that lesions and stimulations of these systems have been shown to be related to such behavioral processes as the sleep-wakefulness cycle, alertness, and attention. Furthermore, the anatomical structure of these systems is of a kind that suggests graded response mechanisms rather than signal transmission. Synapses and dendrites are abundant; fibers are, for the most part, short and fine so that the conduction velocity of an impulse is slow and its amplitude small. Such graded response mechanisms are especially sensitive to changes in their chemical environment: a great number of studies have related the action of neural transmitters and psychopharmacological agents to the functions of these systems (18, 40). Their proximity to the more specialized periventricular receptors is therefore significant to the problem of the "homeostatic" regulation of the organism's *milieu intérieur*, ordinarily referred to by psychologists as mechanisms of drive.

A considerable literature has developed recently with regard to the role of the reticular systems and their forebrain extensions in the regulation of drives. Lindsley (90) and Hebb (62), especially, have spelled out the details of "activation" theories based on neurophysiological evidence. Some constructive criticism of these views has come from investigators who have explored the internal core systems and their forebrain extensions. These investigators have been impressed with the selective action of various locations on specific drive mechanisms. The formulations of central excitatory mechanisms or central motive states as proposed by Beach (12) and by Morgan (111) lean in this direction. The studies of Teitelbaum (147) and of Stellar (144) on the hypothalamic control of feeding and the regulation of thirst and hunger by Miller (103) fall into this category. Most explicit in opposition to an activation theory, yet somewhat different from the selection notion, have been the statements of Olds (115), who has interpreted the data that have resulted from self-stimulation experiments to mean that a central hedonistic mechanism exists. Since animals will work to produce electrical excitation in parts of their brains and will work to stop such stimulation in other parts, a neural "pleasure system" and a neural "displeasure system" are postulated; the "pleasure system" is subdivided into portions that deal differently with sex and hunger. Furthermore, Olds has proposed that the pleasure system works as a positive feedback mechanism, so that an organism's pleasurable activity is stopped only when restraints external to the organism are imposed.

Each of these formulations is based on a particular set of data; each ignores, for the most part, the data upon which the alternate proposals are

based. All of these recent theories share a view that is essentially nonhomeostatic. Activation, selection, and hedonism all emphasize direction rather than equilibration. Attempts have been made to reconcile direction with equilibration. Miller's discussions of the cue properties and the drive properties (conceived in need-reduction terms) of stimuli are probably the best known of these attempts.

Taken together, the neurophysiological and behavioral evidence seems to add up to the view that both an equilibratory and a directional component characterize drives, and that selection, activation, and equilibration are all important. However, hedonism need not be invoked, nor need one consider the selective or cue properties of stimuli as the sole directional components of drive. A simpler view can be formulated. Consider the various elements that make up a homeostat. The sensitive element has already been mentioned, i.e., a homeostat must contain a receptor that is selectively sensitive to the physical or chemical process that is to be regulated. Such receptors exist in the central nervous system. A homeostat is essentially a feedback unit. As such, it must be so constituted that errors in adjustment are fed back to the sensitive element in time for this to signal the disparity to the operate mechanism. Ample neurophysiological and behavioral evidence exists that negative feedback mechanisms exist. After all, this is the evidence upon which the concept of homeostasis rests. But, in addition to these elements of the homeostat, there is another which has been largely ignored. Negative feedback mechanisms are usually equipped with a device by which their bias can be set, e.g., the thermostats in our homes can be set to one or another temperature. The activating mechanisms and electrical self-stimulation can be thought of as changing (by alterations in graded response mechanisms) the biases of the various homeostats with which they are anatomically juxtaposed. The laws that govern the changes in biases would be different from those that govern regulations once the biases have been set. For instance, small increments of change in bias are apt to be accommodated smoothly and are likely to be directional; more abrupt changes are apt to cause marked fluctuations until the regulatory mechanism can again re-establish equilibrium. No simple hedonistic rule can be applied, i.e., behavior is not always guided toward some pleasurable consequence. Selection of stimuli depends on the state of the receptor. Activation shifts biases. Equilibratory homeostasis in the classical sense (and thus need-reduction) is seen as only one phase, the equilibrational, of a rather more complex process. Basic to this process is the up-to-date neural homeostat constituted of a receptor, negative feedback, and bias. Thus the essential mechanism of drive is conceived to be a biased, i.e., a tuneable, homeostat.

The limbic endbrain: multilinked homeostats and dispositions.—Along the innermost edge of the cerebral hemispheres lies a series of structures which, though they differ considerably from each other, share the attribute that they are unlike the rest of the cerebral mantle. Broca gave a unitary name to this conglomerate core of the endbrain, a name which has become ac-

ceptable through usage—the limbic systems. The term is a good one since it does not impute function where function is not known (e.g., rhinencephalon is another name loosely applied to many of the same structures and has the disadvantage that these structures are only remotely related to the nose and to smell). Because of the anatomical diversity within the limbic systems, some anatomists have been loath to make the grouping in this particular way; because of similarities in function, physiologists have stretched the boundaries of the territory so that now one hears that parts of the core of the brain stem should be considered within the limbic systems. Actually, the problem of classification is not so terribly difficult. Within the endbrain, those formations that are usually called limbic can be distinguished on the basis of a precise histological criterion and the classification validated by a variety of equally precise indices (122). Similar classificatory procedures have not as yet been applied to the core structures of the brain stem, so at the moment there is bound to be some confusion. When this becomes sufficiently painful to the neuroanatomists, one of them will, no doubt, undertake the equally painful process of making order out of the present chaos.

What are the functions that have so excited neurophysiologists that they pursue them into the deepest recesses of the brain? The drive-regulating neural mechanisms found in the core of the brain stem have been one source of the challenge. Those which are related to the internal aspects of the endbrain have been more elusive, but equally fascinating. The trouble stems from the fact that a wide variety of seemingly unrelated effects on behavior results when any one of these structures within the limbic endbrain is electrically stimulated or surgically destroyed. Two different points of view have been adopted in the various attempts to categorize the observations: (a) The limbic systems are the substrata concerned with motivational and emotional behavior, motivation and emotion being conceived as primitive, instinctual, visceral reactions; (b) The limbic systems are primarily concerned with memory. Clinical and experimental observation can, of course, be advanced to support both of these interpretations. But these views cannot both be entirely correct since they refer to different sets of data and neither encompasses the data that the other seeks to cover. A review of some of the data will point up the limitations of the current formulations and prepare the ground for a more adequate explanation.

Neurobehavioral studies performed on animals have provided a major source of data. Ablation and stimulation of any of the various structures that make up the limbic systems interfere with a variety of behaviors. These data have been detailed in several recent publications. In order to remain uncommitted with respect to one or another theoretical position and yet have a pedagogically useful categorization, some neutral label that describes this behavioral complex of feeding, fleeing, fighting, and sex, might well be invented. Feeding includes such aspects as hoarding; sex includes mating and maternal manifestations. These data have been used to support the notion that the limbic systems serve motivation and emotion. But when this

notion is examined carefully, the support is seen to be spurious. If motivation and emotion are conceived to be viscerally determined reactions, the limbic systems ought to be primarily concerned with visceral regulation. Indeed, the limbic systems have been called the "visceral brain" (92, 94) in order to emphasize this relation. And special relations with the autonomic nervous system and the viscera do obtain. But these are not selective; other parts of the cerebral mantle (e.g., the motor cortex) also control autonomic and visceral activities and the control which the limbic systems exercise is certainly not limited to viscera or the autonomic nervous system.

An alternate hypothesis has therefore been proposed to account for data in terms of the emotion-motivation notion. This alternative has not always been clearly separated from the visceral hypothesis; often both are invoked (93), the one to account for some facts and the other to be used as soon as the first fails. This second hypothesis is that the limbic systems serve instinctual, innate patterns of behavior, phylogenetically and ontogenetically old (57). Support for this hypothesis comes from comparative neurology, since some of the structures included in the limbic systems are among the oldest to be found in the endbrain. But this hypothesis also fails to be supported upon close scrutiny. All of the structures in the limbic systems are not old: some are accretions as phylogenetically recent as to appear first in primates. And behavior such as fleeing, tested in a conditioned avoidance situation, is learned and highly specific to the situation. Abnormalities of sexual behavior produced by limbic system lesions in cats have been shown to depend not on hypersexuality per se but on the differences between normal and operated cats as to where, i.e., the territorial range, sexual behavior takes place. The experiential components that determine this sort of behavior are not to be ignored. Neither hypothesis is adequate; therefore, the limbic systems cannot be conceived as the neural substrata of motivation and emotion if these are thought of exclusively in terms of visceral-autonomic activities nor if they are felt to be old, primitive, innately determined processes (117). The search for an adequate explanation must continue.

The neurosurgical clinic has inadvertently produced another set of data that bear on this problem. By no stretch of imagination can these data fit simply the rubrics of motivation or emotion. Extensive resections of the medial structures of the temporal lobe of the brain of man, the amygdaloid and hippocampal formations of the limbic systems, result in a very peculiar and dramatic syndrome (104). Patients with such lesions are able to repeat correctly a series of digits that they have just heard for the first time. On this test of immediate memory they are practically as efficient as they were before the lesion was made. Moreover, their memory for events prior to their surgical operation is apparently normal. And they are capable of reacting emotionally in trying situations. But, if distracted, these patients are unable to carry out a sequence of actions, i.e., they are unable to recall what they are supposed to do. If there is an interruption of a test procedure, the patient will not only be unable to continue where he left off; he will, in fact, not even

recall that there was any task at all. If the examiner should be called from the room for a quarter of an hour, the patient will fail to recall that he had ever seen the physician before. This patient can be directed to a grocery store where he can purchase the items on a written list without having to refer to that list any oftener than would a person with an intact brain. But once he has completed the shopping, the patient does not recall what he is supposed to do next and he is completely incapable of finding his way home.

Memory is a complicated affair. Not only must the engram be recorded and stored, it must also be accessible when it is appropriate to the occasion. The syndrome shown by these patients can be summarized by the statement that the patients are unable to recall whatever is necessary to execute a sequence of actions. Given an external plan written out on a piece of paper, the patient can carry on quite well. Where in the memory process the difficulty lies can only be guessed at present; such guesses have been made (26).

On the surface the defect shown by these patients would seem to have little in common with the disturbances noted in the animal experiments. Perhaps a deeper analysis can show that some common elements between them exist. The element common to the activities of feeding, fleeing, fighting, and sex is that they are all comprised of sequences of acts (117). Their disturbance by limbic system lesions depends on the locus of the lesion. After amygdectomy, the threshold for initiating the sequence is high and the behavior runs inappropriately long once it has been initiated (152). Feeding behavior may be difficult to initiate; once it has started it is difficult to stop. After median cortex lesions (cingulate), the maternal behavior of rats is peculiar (142). When a normal mother rat is faced with a situation in which her brood has been strewn around the cage, she will pick up one baby at a time and carry it to the nest, go back to pick up another and return it to the nest, and so forth, until all of the youngsters are safely back in the nest. The lesioned mother rat will pick up an infant, carry it to the nest only to remove it on subsequent trips. After half an hour of this the baby rats are still strewn all over the cage and, eventually, are left to die. What would happen if the mother rat could read, the babies were labelled, and the mother given a written list of directions to plan the retrieval of her brood?

The element common to both the patients with limbic system resections and the animals who show disturbances of the four activities mentioned above seems to be in the execution of certain sequences of actions. Deficiencies appear where the execution depends on some fairly complex plan that has to be carried inside the head. Thus, limbic system lesions can be thought to interfere with behavior because of some defect in the planning mechanism, and not because of disturbed emotion or motivation, nor primarily because of some global defect in memory. Limbic system function is thus conceived to be related primarily to the mechanism of the execution of complex sequences of action.

Analysis of the neural mechanism that underlies the execution of sequences of actions has just begun. Electrical changes have been recorded

from the amygdaloid complex of the limbic systems whenever the organism is exposed to a novel event or one that has meaning in terms of reward and punishment (26, 75). These electrical changes subside once the organism is familiar with the event unless the hippocampal formation of the limbic systems has been ablated, in which case electrical changes continue to occur when this or any other event takes place. The amygdaloid complex is necessary to the establishment of electrocortical conditioned responses. The suggestion has been made that the hippocampal formation inhibits (perhaps by way of the reticular core of the brain stem) the succession of unrelated inputs to the amygdala that might occur and so allows this structure to maintain the neural activity necessary to the conditioning process. In a conditioning or learning situation, electrical changes are recorded from the hippocampal formation during the initial trials; later, no such changes accompany successful action; they occur only when errors are made (1).

These characteristics of limbic system function will again be met later in this review in the discussion of simulated brains. Essentially, when a series of biased homeostats is interconnected, either randomly or hierarchically, and the interconnections have the property of feedback, an ultrastable system results. Such an ultrastable system returns to some predetermined state in the face of perturbations caused by inputs to the component biased homeostats, or by local changes that may result for one or another reason in any one of the components. The system is said to show a disposition to return to the state and to be especially sensitive to error, i.e., to changes in the bias of the components that tend to cause deviations of the system from that state. The interconnections of the limbic forebrain systems with each other and with the structures of the diencephalic and mesencephalic internal core anatomically fulfill the requirements for an ultrastable system. The large tracts that connect the amygdaloid complex and the hippocampal formation with the septal region and the anterior and posterior hypothalamus are well known. The tracts that connect the limbic areas with the mesencephalic reticular core have been emphasized more recently (145). All of these tracts are made up of fibers of varying length, some with one, others with two, still others with several cell stations interposed along the way. Return circuits are legion. Functionally, there is evidence that activity transmitted along these tracts does not result in further propagated neuronal action at the termination of the tract. Rather, graded changes in local potential, especially in dendritic networks, seem to result (52, 53). The changes produced by activity in the system are therefore changes in excitability rather than in the transmission of patterns of signals that convey large amounts of information.

Put together in this way, the data that have been reviewed here suggest that the limbic systems may be conceived to regulate the dispositions of the organism by interconnecting the various biased homeostatic mechanisms of the internal core of the brain stem. Interference with the limbic structures alters these dispositions. The biases of homeostats are set free of each other

and may become overly susceptible to change. Sequences of action that depend on the attainment of equilibration (i.e., completion of one unit of the sequence before the next is begun) suffer disruption. The animal cannot shift control from unit to unit because it cannot complete the test that meets the conditions of equilibrium in any one unit. There is either insensitivity to error or the mechanism that senses error continues to drift so that errors are registered irrespective of the situation (36, 37, 38). The patient with a limbic system lesion cannot order his sequences, cannot plan, if he cannot recall how he was disposed to do something. Memory for how one is supposed to do something is short-lived unless continually supported by external aids: the effect of cramming for an examination by rote memorization outlives the completion of the examination by a few days at best. A change in environment hastens the loss; in a few hours, or even minutes, the memorized material is inaccessible.

This analysis may, at this point, seem to be only a play on words, a bit of verbal magic. But as an hypothesis for further research it may nonetheless prove fruitful. A bit more precision in what is meant may come when the analysis is pursued in the discussion of the frontal intrinsic mechanisms.

In summary, then, the limbic systems are conceived to regulate the dispositions of organisms. The neural mechanisms by which dispositions are achieved are considered to be interconnections of units, each of which is a biased homeostat. Disturbed dispositions disorganize sequences of action by setting free the individual homeostats which then become overly susceptible to changes in bias. Sensitivity to increments in error is sacrificed, control cannot be shifted in an orderly manner from one unit to another of the sequence. The execution of sequences of actions, the execution of plans, is therefore disrupted. Patients cannot do something they are disposed to do; they can only memorize by rote how they are supposed to do it, so instructions have to be repeatedly available.

AN ALTERNATIVE TO THE CONCEPT OF CORTICAL ASSOCIATION AREAS

The conception of "cortical association areas" stems from two sources: Certain portions of the forebrain have obvious major direct connections with peripheral structures while others do not; the empiricist tradition holds that ideas are composed by the association of more elementary units, sensations. After a half century of experimentation, there is no direct evidence to support the notion that ideas are synthesized by association in those parts of the cerebral mantle that do not have obvious direct connections with the periphery. In fact, much of the evidence suggests a contrary view; viz., that the cerebral mechanism does not work by way of some simple transcortical reflex that transfers input from sensory areas to output via motor areas after integration has taken place in the association areas.

In the first place (119), there is direct input from the peripheral receptors, not only to the sensory receiving areas but also to the motor areas of the cortex. Furthermore, relatively direct outputs to muscles are known to

originate in all of the receiving areas. These outputs are independent of those that originate in the motor cortex. Second, when the sensory and motor areas are circumsected or thoroughly crosshatched, very little change in behavior, even in the most complex test situations, can be observed (30, 141, 150). Contrarily, undercutting of these areas produces profound disturbances of discrimination and skilled action. Input and output fibers, rather than transcortical fibers, appear to be the most important to these types of performances. Third, the data that relate the functions of the association areas to behavior cannot be easily fitted into an exclusively associational strait jacket (119). For these reasons, the more neutral "intrinsic systems" is substituted here for the more common term "association areas." "Intrinsic" was originated by Rose & Woolsey (128) to make order in the rather chaotic classifications applied to the dorsal thalamus and its cortical projections. Their intrinsic thalamic nuclei receive no major extrathalamic, extralencephalic input. There are two major divisions of the intrinsic systems: a posterior and a frontal.

The posterior intrinsic systems: an hierarchically organized representational process—reinforcement by cognition.—Analysis of the functions of the posterior intrinsic systems has proceeded at a rapid rate during the last decade or so. Much of this work has been done on rhesus monkeys; some, in the neurologic and neurosurgical clinics. A thorough review of these data was made by Rosvold in last year's *Annual Review of Psychology* (130). This discussion will, therefore, attempt to point out the major issues that have motivated the research, issues that are only partially resolved to date.

When a cerebral lesion impairs the functions of the posterior intrinsic systems, patients show a variety of symptoms and signs having certain similarities and also certain differences from those shown by patients with lesions that impair the functions of the classical projection systems. For the most part, impairment of function of the posterior intrinsic systems, when sufficiently restricted, is also related to one or another sensory mode. For this reason, as well as on the basis of anatomical grounds, the functions of the posterior intrinsic systems and those of the projection systems can be grouped together. Mode specificity is the common characteristic (119).

But the differences in the clinical picture presented by patients with lesions in the projection and in the intrinsic systems are equally impressive. Attempts to portray these differences are familiar—neurologists have spoken of "defective sensibility" and of "agnosia." Psychologists have been interested in teasing apart "existential discriminations" from "differential discriminations" (72) and "sensibility" from "intelligibility" (89, 102). These distinctions are made on the basis of whether the patient reacts to the simple presence or absence of a stimulus event or to some more complex relation between these events. Understanding the distinction appears, therefore, to hinge on comprehension of how organisms recognize stimuli.

We react to environmental patterns as if they are relatively stable configurations. Yet, because of movements made by the organism and changes

that take place in the environmental events, receptors are activated by ceaselessly altering patterns of energy. The constant or invariant properties of the proximal stimulus array must therefore be extracted somehow from these changing patterns. It is the function of the projection systems to accomplish the extraction. The details of the particular way in which this happens have recently been reviewed (153). Some precise guesses have been made in the form of mathematical models and by the simulation of simple neuronal networks in automata studies, and these will be reviewed subsequently. What is certain, however, is that the projection systems make it possible for an organism to respond to the invariant properties of receptor stimulation. For, as Klüver (81) has demonstrated so elegantly for vision, lesions of the projection systems lead to changes in behavior that can be described as follows: Ordinarily, an organism responds selectively to certain properties of the stimulus (e.g., contour, brightness). The range of transformations of these properties (e.g., changing a circle to an ellipse) over which the organism will still make the same response is relatively restricted. After ablations of the occipital cortex, monkeys will respond indiscriminately when the stimulus properties are transformed over a very wide range; only the amount of total luminous flux of the energy that activates the retina is now distinguished. Differences of flux that result in changes of luminance, contrast, and contour have no effect in altering the monkey's reaction. In the absence of the projection system mechanism, the organism cannot extract restricted invariant properties from the retinal excitation. It shows a defect in sensibility in making existential discriminations.

When the functions of the posterior intrinsic systems are interfered with, existential discriminations remain intact. A monkey with such a defect will catch a gnat in mid-air (17); he reacts to variations of illumination by varying his rate of response in an operant situation (43). But when he is given alternative responses to make to differences in luminance, pattern, etc. (the alternative indicated by a peanut, for example), he fails to make any consistent choice (27, 28, 29, 107, 110). It is apparent, however, that even this complex relation between cues, alternatives for response and the indicators of these alternatives allows some invariant properties to be extracted. Otherwise, intact monkeys and people would not be able to respond consistently. Somehow, through repetition in time, these properties are identified; and, when the functions of the posterior intrinsic systems are interfered with, identification goes awry. The situation becomes unintelligible to the organism; it cannot make the differential discrimination; it does not know what to do; it has an agnosia.

The posterior intrinsic system must, in some way or other, make possible the separation of the invariant properties that characterize the situation in contrast with other, less regular variables. This could be accomplished if some coded representation of the invariance is established in the posterior intrinsic mechanism. The neuronal patterns that form the representation can be conceived to be of the sort that Hebb (63, 64) has popularized as "cell

assemblies" with additional inhibitory properties such as those used by Milner in his Mark II modification (105). More in accord with the known complexities of the neural net, the neuronal patterns may be characterized in the manner suggested by Beurle (14), who bases his model on the cytological work of Sholl (137), and takes into account the graded response mechanisms emphasized earlier in this review. Beurle has worked out in some mathematical detail a mechanism of cortical function based on interacting waves of excitations or "interference patterns" that were first proposed by Lashley (86). However the representation is produced, it must be formed according to some rules established either by the innate structure of the nervous system or through experience. These rules proscribe constraints on the otherwise random properties of the neural network. The rules themselves, i.e., the properties of the network and therefore of the representation, are apparently modifiable, over time, by a variety of variables recurrent in the situation. However, the modification is selective, so that it must take place by some mechanism whereby the representation has efferent control over these variables (119, 120): by selective attention, in other words. What is selected could depend on some kind of match-mismatch process as described by MacKay (95) and by Bruner (21).

The selective process as it is detailed by these and other authors would provide the mechanism required by Harlow in his theory of discrimination learning (59). This mechanism also serves the purposes needed by the Gibsons (49, 51) to account for their findings that discrimination learning is a process of progressive differentiation, not a process of association. But perhaps the model has its greatest power in the description of what constitutes reinforcement for the organism. The posterior intrinsic mechanism, because of the hierarchical nature of its selective control over its own modification, allows a change in the representation to occur by trial and error. Whenever the error signal is such that the corrective change is not uniquely specified, the representation is modified to include this information, and trials continue. Thus an organism that possesses this mechanism can, given a relatively unchanging or slowly changing environment, search that environment for the additional information that is needed to make the organism fully informed. The neural model would thus account for the search through negative instances as these are defined in the stimulus-sampling type of stochastic learning theories (24, 41, 42, 56), search by an information-hungry organism reinforced or satisfied only when corrective change of the representation is immediate and can be deduced uniquely from the error signal. Stated in this way, reinforcement becomes one side of the coin of similarity! But more of this when the functions of the frontal intrinsic system are presented.

Techniques are already devised to test some of these notions directly. Microelectrode recordings made from cells located in the intrinsic systems show that the patterns of impulses they emit change as the animal learns to make a discrimination (74). Conversely, disruption of electrical activity

by mild electrical stimulation or by aluminum hydroxide cream applied to the intrinsic cortex interferes with discrimination learning, although performance of the same task remains intact under these conditions (114, 143). These and other preliminary behavioral data (116) suggest that this way of looking at the functions of the posterior intrinsic systems, though it may be wrong in detail, is a somewhat closer approximation to fact than the older theories based on the notion of the transcortical reflex.

The frontal intrinsic system: the association cortex for the limbic systems—intentions.—Views of the functions of the frontal intrinsic system have varied a good deal and, since the advent of psychosurgery, have usually gone to extremes. There are those who hold that the frontal cortex of man is the "organ of civilization" (58) and that tampering with this structure comes close to criminal action. On the other hand, there are those who claim that no consistent effects are ever observed to follow frontal lobectomy or leukotomy (99). What is the evidence?

Only a few standard psychological tests have been successful in demonstrating any change in the psychosurgical patient. The Porteus maze, the digit-span recall portions of intelligence tests, and nonsense-syllable recall seem most often impaired (134). Yet, psychiatrists and persons who are in close contact with a postlobotomy patient have no difficulty in spotting the fact that some important change has taken place in the patient. The manifestation of the change depends in part on the presurgical illness for which the patient was operated on; in part it depends on the premorbid personality of the patient. Obsessive and compulsive behavior is alleviated in many instances; chronic tensions and anxiety are relieved. All this at a price, and the price is so hard to define. Perhaps the difficulty lies in the approach to the problem. The change is not so much in what the person can or cannot do but in how he does it. Porteus maze, digit span, and interaction chronography (98a,b) are techniques that come closest to measuring "how" rather than "what," and thus they are the most sensitive to the changes produced by the psychosurgery.

A great deal of precise information about the effects of frontal intrinsic cortex lesions has been obtained from subhuman primates. These data have been extensively reviewed in these volumes from time to time, most recently, last year (130). Essentially, the story is this: In an attempt to show that animals, as well as people, have "ideas," Hunter (67) invented a simple task. Success depended on the organism's ability to recall some transient event that (a) changed from trial to trial, (b) characterized the situation at the time the task was set, but (c) had disappeared by the time response was allowed to occur. This delayed-reaction task and some other similar tasks that were derived from it (e.g., the delayed alteration, the double alteration, etc.) were found by Jacobsen and his collaborators (70, 71) to be sensitive and selective indices of the functional integrity of the frontal intrinsic cortex of subhuman primates. The question remained to be answered as to just what was the nature of the "ideas" that the tasks were presumed to test

for, and just what could be the neural mechanism that mediated them. During the past two decades, a considerable amount of data has accumulated and these data do suggest some explanations.

The problem of frontal lobe function is thus seen to be somewhat similar to that faced in the discussion of the functions of the limbic systems. Two sets of data appear, on superficial examination, to be irreconcilable. The data obtained with "limbic" patients and "frontal" animals point to a memory defect; the data obtained with "limbic" animals and "frontal" patients point primarily to defective emotional-motivational processes. In the discussion of the limbic systems, reconciliation was effected when both types of change were considered to be due to failures on the part of the damaged organism to carry out complex sequences of action. Perhaps this approach will serve as well for the discussion of the functions of the frontal cortex.

First, in contrast to the effects of posterior intrinsic system lesions, the effects of frontal lesions are nonspecific with respect to sensory modality. There is an abundance of anatomical and physiological evidence that the frontal intrinsic system is closely connected with the nonmodality-specific systems of the internal core of the brain stem and the related limbic formations of the endbrain. This evidence is reviewed in detail in a recent publication (117) and so does not need to be recapitulated here. In short, the frontal intrinsic system can be conceived as the "association cortex" for the limbic systems. And these, as already noted, deal with the dispositions of the organism that are necessary to maintain sufficient stability to allow the execution of complex sequences of action.

Second, data have accumulated to show that frontal lesions interfere with whatever occurs at the time the delay task is set in the delayed reaction type of experiment, not with the process of recall (at the time response is allowed) *per se* (108, 109, 123). Thus, the frontal lesion appears to interfere with the monkey's ability to be instructed as to how to behave in a subsequent portion of the situation. The lesioned monkey is not able to perform as he is supposed to perform unless the instructions are present in the environment at the time a response is required. He cannot recall an instruction that, to him, did not instruct. The defect appears to be less that of "immediate memory" than that of confusion of intention, *i.e.*, of how sequences of actions are to be executed. This confusion seems to be due to an inability to arrange and utilize the information given by the task in the absence of persistent and detailed external instructions.

Stated in this way, the defect that follows frontal lobe lesions in primates might be attributed to a defective representation of intentions. The frontal representations can be conceived to have properties similar to those described for the representational process of the posterior intrinsic systems. The representation is based on some more or less random network of neurons constrained by rules that are partly determined by the nature of the network and partly by experience. The experience that modifies the representation is selected: the representation, by a hierarchically organized match-mismatch

process, efferently controls the mechanism that determines error. But what will serve as an error signal for the process differs in origin for the frontal and for the posterior systems. Because of its connections with the projection systems, the posterior intrinsic mechanism is sensitive to differences between past and present constancies in receptor stimulation. The frontal intrinsic mechanism, on the other hand, by virtue of its connections with the limbic systems, is sensitive to differences between past and present constancies in the dispositional states of the organism. An error signal would be instituted whenever the representation of past perturbations of the ultrastable dispositions of the organism did not match present perturbations. The hierarchical organization of the process would allow change in the representation to occur by trial and error: the modification would be selectively controlled by the representation. Whenever the error signal is such that corrective change is not uniquely specified, the representation is modified to include this information, and trials continue. Thus an organism that possesses this mechanism can, given relatively unchanging or slowly changing conditions, search those conditions for the additional instructions that are needed to make it fully instructed. The organism would be reinforced only when corrective change of the representation could be deduced uniquely from the error signal, i.e., when further change in the representation is precluded. Stated in another way, the organism is "gratified" only when he can do things pretty much as he intends to do them. Given the frontal mechanism, his intentions can be uniquely gratified in any particular set of circumstances. In the absence of the frontal representational mechanism, gratification, i.e., reinforcement, would result from a greater variety of conditions; thus "trials" would cease to be trials that provide instructions.

The subhuman primate, and even man, is relatively limited in the capacity to be instructed without the aid of external crutches such as written words, mathematical tables, and pencil and paper figuring. The delayed-reaction situation is at the limit of the capacity of subhuman primates; digit-span recall, when distraction intervenes, appears to be close to the limit of human performance. Try to recite two series of seven random digits, each presented only once and the second presented before an opportunity for recitation of the first is given. Even the "organ of civilization" isn't good enough for that one.

In summary, then, the frontal intrinsic mechanism shares characteristics with the posterior intrinsic systems. Both are conceived as the locus of representations sensitive to, but not exclusively determined by, experience. The intrinsic representative process is based on neural network which is constrained by some innate properties (such as inhibitory mechanisms, graded response characteristics, and differences in interconnections and, therefore, in the timing of firing patterns) and by the effects of experience. However, the experience that modifies the representation is only partly determined by circumstance. Equally important is the selection of the experience on the basis of the representation, the selection accomplished by an efferent mech-

anism that originates in the intrinsic systems. The intrinsic representational process is thus hierarchically organized. It is altered only by what it allows itself to be altered by. It is sensitive to variations in circumstance, provided that these variations are not overly abrupt.

The differences in function between the frontal and the posterior intrinsic mechanisms stem from differences of their connections. The posterior systems are primarily related to major projection systems that are organized to select the invariant properties of receptor stimulation. The frontal mechanism is primarily related to the limbic formations of the endbrain that are organized to enhance constancies of state that depend on the biased homeostats of the brain-stem core. The posterior intrinsic mechanism, therefore, is sensitive to differences between current and past receptor-stimulation; the frontal intrinsic mechanism is sensitive to differences between current and past perturbations of states of the organism. By virtue of its *posterior* intrinsic mechanism, the organism is reinforced or satisfied only when it is fully informed, i.e., when corrective change of the representation is uniquely specified by current receptor stimulation. Search for information continues until this condition is met. By virtue of its *frontal* intrinsic mechanism, the organism is reinforced or gratified only when it is fully instructed, i.e., when corrective change of this representation is uniquely specified by current perturbations of organismic states. Attention to instructions continues until this condition is met. Reinforcement conceived as satisfaction turns out to be the identification of similarities; reinforcement as gratification, the fulfillment of intentions. A somewhat different view than that derived from S-R reflexology and classical associationism!

SITUATIONAL DETERMINANTS

No discussion of functional localization within the central nervous system is complete without some mention of the troublesome problem of what is localized. Most of the objections against localization have been raised because it is deemed logically inadmissible to localize mental functions in the physical brain. Parallelism, reductionism, and phenomenal or physicalistic monism have all been invented to surmount this issue. Another course can be taken (118). Different parts of the brain are shown to have different functions: The frontal lobes and the occipital cortex regulate different aspects of the organism's behavior. But these different functions are not to be the loci of some simple psychological process inferred directly from the observed behavior. Rather, the brain process is shown to be a critical determinant of the behavior under certain conditions (121). Only when these conditions are thoroughly explored can the brain process be adequately specified. Specification is, as a rule, in terms somewhat different from those derived exclusively from the observations of behavior that initially instigated the localization research. The brain processes, in other words, constitute only one, albeit often a critical one, of the several classes of variables that determine the organization of behavior. Brain processes and psychological processes are

thus not identical, nor parallel. Psychological processes represent a different and more complex level of discourse. Thus, the psychological process is characterized by properties unique to this level of organization. Specification of the properties of the component elements of this organization, while a proper pursuit of science in its own right, must not be confused with the search for specification of all of the properties of the more complex organization. The aim of neuropsychology, i.e., to specify brain processes that critically determine the organization of behavior, is thus seen to be a limited one. An example may serve to illustrate some of the steps that can be taken to realize this limited aim.

Resection of the amygdaloid complex of the limbic systems of the end-brain results in a syndrome (discussed earlier in this review) that includes, in several species, extreme taming and hypersexuality (82). A series of experiments undertaken to quantify the taming (fleeing and fighting) by measuring the reactions of monkeys in a social dominance hierarchy disclosed that taming is not always produced (131). In fact, whenever the number two animal in the hierarchy is fairly unreactive and the dominant monkey is the one operated on, then the operated monkey remains dominant and may indeed become even more aggressive than he had been before operation. A similar result is obtained when pairs of animals are tested against each other or when operated monkeys are handled in several different ways by their keepers after surgery (152). Amygdalectomy, therefore, does not necessarily produce taming: the amygdala is not the "seat of aggressivity." Rather, as Weiskrantz has suggested, amygdaloidectomy can be conceived as an interference with a mechanism that relates the momentary social behavior of the monkey to its prior behavior. In this situation, as in others such as food-rewarded operant-conditioning experiments, the amygdaloid mechanism can thus be tentatively but usefully conceptualized, as Schwartzbaum (135) has done, as a governor of generalization based on experience.

Support for this view of the functions of the amygdaloid region comes from careful study of the effects of amygdalectomy on sexual behavior. Hypersexuality was the immediately obvious effect (133). Hormone studies, etc., were undertaken, only to give equivocal results. But control of the situation (57a) in which the hypersexuality was seen to occur, and comparison with the range of normal animals' sexual behavior, made it clear that cats, at least, behave sexually in much the same way whether they possess their amygdaloid complex or not. However, the occasions on which, and the territory in which, they display sexual behavior are markedly affected by amygdalectomy. Normal cats restrict their sexual activities to their own territory and to their own species, types of mates and situations thoroughly explored and delimited through prior experience. Cats devoid of their amygdaloid region, on the other hand, suffer no such restrictions; they behave according to their momentary dispositions without regard to other factors. But, even in this context, the effects of lesions are not always totally disruptive. Certainly, then, the amygdala cannot be conceived as

some simple "sex center." The more appropriate view is attained only after careful exploration of the situational determinants of the behavior that is studied: in these situations, as in those in which dominance was studied, the amygdaloid mechanism can be tentatively thought to govern generalization based on experience.

The amygdaloid complex is one of the formations of the limbic systems of the endbrain. Already reviewed are the data demonstrating that these formations make possible the execution of complex sequences of action. The anatomical and physiological evidence suggests, as was detailed earlier, that the limbic formations organize the biased homeostats of the central core of the brain stem into an ultrastable multilinked mechanism sensitive to events that result in changes of the excitability of the system. The experiments on dominance and on sexual behavior suggest that the amygdaloid region is involved in these functions as a mechanism that allows current changes in excitability due to social and sexual stimulation to be constrained by the effects of past experience and, perhaps, by other classes of variables such as the total situation, nonsocial and nonsexual excitations (e.g., hunger), etc. The effect of the lesions in the amygdaloid region on the execution of the sequences of action necessary to dominance and mating is therefore not to be conceived as some change in the response mechanism per se; rather, the change is in some properties of the antecedents that determine the behavior. The range over which these antecedents are changed is a matter for laboratory test. Preliminary experiments suggest that generalization as tested in a transposition situation is as affected by amygdalectomy as is generalization in a social and sexual situation (135a). Thus, the function of the amygdaloid complex is characterized as a mechanism involved in stimulus generalization or stimulus comparison which may or may not be especially limited to this or that situation. Should it turn out, as is beginning to appear, that the mechanism is important in a wide variety of situations, then the problem arises as to how it is that a defect in the mechanism affects especially the execution of complex sequences of actions. In other words, how do the dispositions of the organism determine the generalization process? Thus, by progressive approximation, questions are asked that are at the same time more specific in neurophysiological and neurobehavioral detail and more general in their application to a wide variety of problems of psychological function. Such a step-by-step analysis, by providing concepts of mechanism at several levels, seems to steer clear of metaphysical difficulties.

SIMULATED BRAINS, COMPUTERS, AND AUTOMATA

The picture of the central nervous system to which our theory leads is a picture of a more complex and active system than that contemplated by most associationists. The notions of "trace," "fixation," "excitation" and "inhibition" suggest a relatively passive electrochemical system (or, alternatively, a passive "switchboard") acted upon by stimuli, altered by that action, and subsequently behaving in a modified manner when later stimuli impinge on it. In contrast, we postulate an information processing system with large storage capacity that holds, among other things, com-

plex strategies (programs) that may be evoked by stimuli. The stimulus determines what strategy will be evoked; the content of these strategies is already largely determined by the previous experience of the system. The ability of the system to respond in complex and highly selective ways to simple stimuli is a consequence of this storage of programs and this "active" response to stimuli (113).

The author of the present review came across this passage, so closely paralleling his own thinking, during his readings preparatory to the composition of this last section. The article from which the above quotation is taken was not written by physiological psychologists in the classical sense of the term. In fact, the men responsible for these ideas might well need resuscitation were they to experience the travails of the neurosurgical or neuropsychological operating procedure. Their *métier* is made of pencil and paper, of solder and magnetic tape, not of Wisconsin and Operant boxes, not of primate bone and brain. Yet their contribution to the subject matter of physiological psychology—and that of many others who work with similar tools—can be ignored by their bloodier colleagues only at a price. Mathematical and metal models of brains can teach much. In fact, they have already taught much to those whose intense interest has surmounted the obstacles posed by mastery of three separate disciplines: physiology, psychology, and communications and control engineering. The problems faced are similar in all three areas: What are the component elements of nervous systems and computers and how are they organized into functional systems? How do automata or organisms control their own behavior? What kinds of mechanisms do we need to explain this or that psychological phenomenon? The last section of this review is not written with any sense of competence in communications and control engineering; nonetheless, the matter is sufficiently important to warrant the attempt to bring together in one place all three domains of neuropsychology.

BASIC MECHANISMS

Components.—The components of simulated brains are of two sorts: digital and analogue. The digital components serve functions that were discussed earlier as all-or-none; the analogue mechanisms are akin to the graded response processes emphasized recently in the study of animal and human brains. Digital elements are characterized by the fact that they can exist in only one of a discrete number (usually small) of states. Thus a wall switch that controls the ceiling light is a digital mechanism. Analogue elements are characterized by the fact that they can be in one of a continuously variable series of states. The volume control of a radio is an example of such an element. For the most part, computers have been developed from digital elements; automata from analogue elements. But whenever the behavior that the mechanism is to simulate is at all complicated, combinations of the two sorts of components are necessary.

Simple automata.—The best known automata are Walter's turtle (151) and Ashby's "homeostat" (7). The turtle can respond to two types of input:

light intensity and touch. It moves about, and can escape from enclosures and the like. Additional circuitry allows it to learn. This circuitry is essentially a memory of the resonating (feedback) type and makes the turtle extremely sensitive to repeated transients that are within the frequency range to which the circuit is tuned. As Walter puts it, this "sensitivity to rhythmic stimuli would be a serious fault in a tool machine but is a virtue in lifelike toy, for it exists in animals." Some insight into the "theory of learning and the temperaments (dispositions) of the learners" can be gained from the settings that have to be made in order to allow the model to perform as "sensibly" as would a "good" animal.

The problem of equilibration is faced in the turtle; it is tackled more specifically in the design of the homeostat. This design is a complex of simple servos of the nature of the TOTE units discussed earlier. The units are interconnected by feedback loops so arranged as to provide initially a somewhat chaotic system. Each unit then acts on the others to enforce changes in the system as a whole that will bring it to some stable state. Any perturbation of the system, irrespective of how produced, will be temporary; the system will again interact until the stable state is attained. The system has been characterized as being ultrastable and as showing a disposition to attain the particular state toward which it is always restored. Again, some additional feedback memory circuitry can be developed to modify the mechanism so that it can select its dispositions: thus problem solving, as a process of selection of information, is accomplished (8). This is only one of many specific suggestions made to this end; others are described in the following section.

MATHEMATICAL AND METAL MODELS OF PSYCHOLOGICAL PROCESSES

Representation, recognition, and cognition.—Patterns can be selectively reacted to by machines that are devoid of feedback loops. The essential organization is one of convergence and divergence in a random net of connections of the elements. Early attempts produced devices of very limited capacity. Only the presence or absence of some predetermined environmental event was effective in altering the response of the system, much as was the case with the turtle. For more complex systems the simple convergence-divergence property of the mechanism had to be modified. Two types of modification have been made. The first includes inhibitory as well as excitatory processes. Milner (105) has modified Hebb's cell-assembly structure (63) to this effect. This modification was found to be necessary when Gelernter & Rochester (46, 127a) attempted to build a metal model of Hebb's "conceptual nervous system" and found that it learned much too much ever too fast. Mark II with its inhibitory circuitry gets around this.

The other way in which the problem has been solved is to put into the system some method of time delay between the arrival or activation of various signals generated by any particular input. McCulloch & Pitts' scansion device is of this nature (96). Uttley's method for sensing patterns with a conditional probability machine is another example (148, 149).

Licklider's model of the auditory mechanism as an autocorrelation computer is yet another (89).

All of these systems are based on the assumption of a random network of interconnected elements. The signal passes through the network on a probabilistic basis. Thus, it is stochastically determined whether or not any particular element is activated. Any method that biases the probability of reaction of any of the units therefore limits the initially random nature of the net. Inhibitory mechanisms, scansions, and time delays produce such biases and therefore constrain the system. The constrained system reacts differently from the free one; the amount of constraint can be predetermined (e.g., by nonrandom connections of neural or computer elements) or it can vary as a function of successive inputs, etc. (80, 106).

The above models have the virtue that they can react immediately to certain stimulus patterns and that there is flexibility with respect to which patterns a particular machine can react to at any particular time. But in order to behave selectively on the basis of the representation, additional circuits are required; and, as in the case of simple automata, these circuits are recursive, i.e., they have the special property of a feedback that modifies subsequent activity in the system and is, in turn, modified by the modification. This property allows the machine to match the current input with some representational process. The representation may be built into the model or set up by prior inputs or be the resultant of the interaction of both (80). The representational process can be a purely topological one; in that case, the representation is some sort of filtrate of the input (19). More interesting are the situations in which the representation is formed by a set of rules which describe the constraints on the system. These representations are thus coded transformations of that which they represent. The code or rule does not need, therefore, to resemble the input pattern. Match is determined by fit to the rule, not by some qualitative correspondence. The variety of rules that can accomplish this effect is legion. Some examples show the range over which these devices can operate.

When the rules that are the representation comprise coded transformations of the physical parameters of the input, perceptual phenomena may be reproduced by machine (129). The computer may be programmed with various geometrical transformations that have been shown to operate on optical arrays to produce the standard visual phenomena that guide our behavior. The experiments performed by Gibson (50) and those of the Ames group (5) have detailed some of these rules; when these are used as programs, complex visual displays can be synthesized from relatively simple elementary inputs.

MacKay, to whom this review is repeatedly indebted, has taken the problem one step further (95). He makes the interconnections between elements of a system function probabilistically. Specifically, this produces a mechanism in which the probability of excitation of each element can be made to depend on continuously variable physical factors as well as on the

current states of any one of the other elements linked to it, as in the simple automata described by Ashby and Walter. In other words, graded response mechanisms are posited to influence not only each element but also the relations between them. A system is then arranged so that the incoming signals stimulate the representation and in this way set it to adapt and match or counterbalance the signal by its internal activity. By continually modifying its activity (according to some rule) to match the incoming signals, the mechanism may be thought of as hierarchical: i.e., as symbolizing those features of the received information that have necessitated the modifications. MacKay states:

The symbol generated in this way must remain the same under all transformations of the input with respect to which the rule or "concept" is invariant. The internal activity evoked in the matching-response to the incoming signals is outward directed; and it is the outward-directed activity of the elements organizing the internal matching-response, that constitutes the basic symbols that now make up the concept. Selection is accomplished not by filtration but by an active searching process. Error is recognized.

Shades of the workings of the intrinsic mechanisms of the brain as these were described on pages earlier

Logic.—MacKay calls his machine an epistemological automaton. He leaves somewhat vague the nature of how the rules are formed that guide his machine to modify the representational activity to match the input. But rule formation has also been tackled by theoreticians familiar with simulated brains. Von Neumann (112), for example, discusses the synthesis of reliable organisms from unreliable components and comes up with a method for the study of a probabilistic logic. Carrying on from the fundamental work of McCulloch & Pitts (96), von Neumann details the types of elements, their connections, and the results that can be obtained from several of the possible networks. He uses inhibitory as well as excitatory circuits; he does not, however, deal with the effects that graded response mechanisms might have on these systems.

A still different approach to the simulation of logical processes is taken by those who have been primarily concerned with the programming of existing computers. An outstanding contribution to this approach comes from Newell, Shaw & Simon (113). The authors talk about computers whose components are of the von Neumann type, and of problem-solving organisms as information processing devices. Information processing is programmed. Programs are made of lists of elements. Elements consist of an item, the address (identification number) of that item, and an address of some other (predetermined) item. Elements are stored in a memory and are made available to computation when their address appears on the initial list that is fed into the computer. Thus a hierarchy of lists constitutes the "information processing language." A special device, an interpretive routine, has to keep track of where, in any particular list, the process has shifted to a sublist. Without

this routine the computer would stop after it had exhausted the items on the sublist.

The model of problem solving that is provided by their logic theorist is startling in its similarity to the neuropsychological model developed in the body of this review. The latter is based on neurophysiological and neurobehavioral data (116, 120) and on mathematical models, especially the American statistical learning theories (24, 41, 42, 56) and the British simulation and automata studies (7, 8, 14, 19, 36, 37, 38, 95, 137, 148, 149, 153). The logic theorist, on the other hand, was derived almost wholly by programming computers. Another quotation from the paper by Newell, Shaw & Simon (113) shows the extent of congruence that has resulted:

Problem solving is said to involve (a) finding means of solution, and (b) applying them. A counterpart in the logic theorist is the division between the similarity routines which find "likely" materials for a proof, and the matching routines, which try to use these materials. In applying means (matching routines), there are needed both *ordering* processes (to assign priorities when more than one method is available) and *control* processes (to evaluate the application).

Newell, Shaw & Simon's "similarity routines" correspond to neurobehavioral theory when reinforcement (as a function of the posterior intrinsic mechanism) is conceived as the identification of similarities. Their "matching routines" correspond to the neurobehaviorally derived statement that the defect that follows frontal lesions in primates appears to be "less that of immediate memory than that of confusion of intention—i.e., of how sequences of actions are to be executed. This confusion seems to be the result of an inability to arrange and utilize the information given by the task." "The ordering processes (to assign priorities when there is more than one method available)" of the logic theorist correspond to the neurobehavioral process described as "the defect that follows frontal lobe lesions in primates—attributed to a defective representation of intentions." And to push the analogy to the extreme: the computer's "control processes (to evaluate the application)" could correspond to the neural mechanism involved when the animal with limbic lesions "cannot shift control from unit to unit because it cannot complete the test that meets the conditions of equilibrium in any one unit—there is insensitivity to error, or, the mechanism that senses error continues to drift so that errors are registered irrespective of the situation." Such convergence in detail of completely independent theory constructions suggests that perhaps at last neuropsychologists have seized some psychological truths by the tail.

RECAPITULATION

A great deal of ground has been covered. Theorists have not been idle in physiological psychology—though, until very recently, their efforts have been overshadowed by those of the data gatherers. Some illuminating threads run through the various arguments and these have been followed, pulled out,

and used to weave a cloth from the strands of data that have accumulated. A consistent view of the regulation of behavior by the nervous system has resulted, and forms the substance of this review. In conclusion, these threads may profitably be identified as they appear in their new matrix.

a. An hierarchically organized representational process is conceived as necessary and sufficient to account for reinforcement. The build-up of a representation in metal or neural systems has long been recognized as an important mechanism if the facts of a behavioral psychology were to be dealt with. Lashley (86), Hebb (63), and Broadbent (19), especially, have recently spelled out the implications for physiological psychology that such representational processes provide. As exemplified in the work reviewed, a great deal has been done with the problem of how the representation is constructed and how it may operate. But the importance of the hierarchical nature of the organization that is necessary if the representation is to do the work that it must for psychology was largely ignored until MacKay (95) focused attention on the problem. The hierarchical organization of the representational process makes it possible for the representation to be modified selectively. The selection, in turn, depends on the representation, so that in an unchanging or gradually changing situation the representation can achieve a unique match with the situation. This possibility provides the key to the puzzle of what is reinforcing to an organism. Only when unique match is achieved will the organism stop search. Only then will it come to asymptote in learning. Only then will the probability be maximized that a particular response alternative is chosen.

b. Two kinds of reinforcing mechanisms were distinguished. Two sorts of programs are necessary to allow a computer to solve problems: programs that gather information and programs that order and utilize the information that has been gathered. The brain also has two major programming devices, the posterior and the frontal intrinsic systems. The posterior, by virtue of its connections with the classical projection areas, is sensitive to differences between past and present invariances in receptor stimulation. It is thus suited to aid the organism's search for information. Because of the hierarchical nature of the representational process, search for information in any particular situation proceeds until the organism is fully informed in that situation, i.e., until he has complete knowledge. Only then is he satisfied. The frontal mechanism works in similar manner, but, by virtue of its connections with the limbic systems, this mechanism is sensitive to differences between past and present perturbations of the dispositional states of the organism. As a result of the operation of this mechanism, the organism remains active until it is fully instructed, i.e., until it has the know-how to arrange and utilize information. Only then is it gratified. By the use of their intrinsic systems, organisms are thus able to display both knowledge and wisdom.

c. Ultrastable dispositional states are accomplished for automata and for flesh and blood organisms by multilinking several homeostatic units. This organization is performed for the organism by the functions and connections

of the limbic systems of the endbrain. These systems were conceived to control the biases of the homeostats of the central core of the brain stem and thus make possible the ordering of behavioral processes—the execution of sequences of action. Lesions of the limbic systems disjoin the homeostats and set them free so that small changes in conditions no longer register as errors. The biases of the homeostats become overly susceptible to the change. The equilibratory mechanism is thus easily thrown into oscillation. Or the bias may drift so that error is registered irrespective of the situation. As a result, the organism cannot test to determine whether any element in a sequence has been completed. Thus, the limbic mechanisms of the endbrain are conceived to control the dispositions of the organism: the reported effects that lesions have on the memory process and on motivation and emotion are thought to be secondary to disturbances of dispositional states.

d. The theory of homeostasis is based on the fact that equilibratory regulation of a function is accomplished through a mechanism whose sensitivity controls that to which it is sensitive. Homeostats abound in the internal core of the brain stem. But, recently, an adjacent mechanism has been discovered: the modality nonspecific activating systems. Data obtained from stimulations and destructions of these systems have been interpreted to support directional theories of drive. Directional theories are of three types: generalized activation, specific sensory, and hedonistic (pain and pleasure). These may all be more or less apposed to equilibrational or optimal state notions. None of these ways of looking at the mechanism of drive is satisfactory since none of them subsumes a large enough body of the data that are covered by the other theories. A somewhat more adequate picture has been obtained upon consideration of the complete mechanism of the homeostat. Homeostats such as the thermostat can be tuned or set; they are subject to bias. The activating mechanisms, adjacent to the core homeostats, function primarily as graded response mechanisms. Changes in their excitability can be conceived to alter the biases of the homeostatic mechanisms that they surround. Biased homeostats can function either in an equilibrational or a directional fashion, or they may oscillate. When biases are set, equilibration results from the operation of the homeostat. When biases are shifted slowly, the homeostat adjusts and direction is achieved. When biases are altered rapidly, marked oscillations can ensue. Drive, as regulated by biased homeostats, is therefore neither purely directional, purely equilibrational, nor purely hedonistic.

e. Until the past few years neural function was conceived primarily in terms of impulsive activity, or signal transmission. Now it is recognized that changes in excitability, or graded responses of neural tissue, are as important to an understanding of function as is the transmission of impulses. The all-or-none law has been modified in favor of an all-or-something law. Graded responses are characteristic of fine fibers, especially dendrites, and of synapses. They are thus the prepotent mechanisms in such locations as the nonspecific systems of the brain-stem core and the dendritic layers of the

cerebral cortex. Graded responses can account for phenomena that are not accounted for when the nervous system is conceived entirely in terms of signal transmission. The biasing of homeostatic control of drives is one example. Köhler's (83) explanations of the mechanism of some perceptual phenomena and Lashley's (86) and Beurle's (14) conceptions of cortical function in terms of interference patterns are others that today seem not at all farfetched.

f. The homeostat is an example of a unit of organization of the nervous system and of behavior that may have to replace the S-R reflex-arc concept. The reflex arc must, in the light of the new data, be modified to include efferent control of the receptor element of the arc. This modified unit is a simple servomechanism. Complication of the unit of analysis requires a review of some notions that are held about what constitutes a stimulus for an organism and for what reason the organism responds. The suggestion is made that a sequence of functions describes the way in which servos work. There is a test phase in which a congruity or incongruity between the state of the test unit (e.g., the receptor) and an input to it is sensed. Incongruity shifts control from the test phase to an operate phase during which process the organism and the environment are changed until the input to the test is congruous. Then, and only then, are the conditions satisfied that allow transfer of control to other units, i.e., exit from the servo. This Test-Operate-Test-Exit (TOTE) unit places emphasis on an active organism that controls the stimuli to which it is sensitive and upon which it acts. This conception differs from an S-R reflex-arc concept in which a passive organism is completely subject to the exigencies of its environment.

g. This view of an active organism gains support from the fact that the central nervous system, in conjunction with its receptors, is intrinsically and spontaneously active. Electrical activity is recorded in the total absence of environmental input. Even brief stimulation has long-lasting aftereffects that alter the intrinsic rhythms for hours and days and thus change the response of the organism to subsequent stimulation.

Reinforcement by cognition, based on a mechanism of hierarchically organized representations; dispositions and drives regulated by multilinked and biased homeostats; representational organization by virtue of graded, as well as all-or-nothing, neural responses; spontaneously generated, long-lasting intrinsic neural rhythms: organisms thus conceived are actively engaged, not only in the manipulation of artifacts, but in the organization of their perceptions, satisfactions, and gratifications.

LITERATURE CITED

1. Adey, R. (Presented at Am. Acad. Neurol., Symposium on the Rhinencephalon, April 17, 1959)
2. Adrian, E. D., and Matthews, R. The action of light on the eye. Part I. The discharge of impulses in the optic nerve and its relation to the electric charge in the retina. *J. Physiol.*, **63**, 378-414 (1927)
3. Adrian, E. D., and Matthews, R. The action of light on the eye. Part II. The processes involved in retinal excitation. *J. Physiol.*, **64**, 279-301 (1927)
4. Adrian, E. D., and Zotterman, Y. The impulses produced by sensory nerve-ending. Part 2. The response of a single end-organ. *J. Physiol.*, **61**, 151-71 (1926)
5. Ames, A. Binocular vision as affected by relations between uniocular stimulus-patterns in commonplace environments. *Am. J. Psychol.*, **59**, 333-57 (1946)
6. Andersson, B., *Experientia*, **8**, 157 (1952)
7. Ashby, W. R. *Design for a Brain* (John Wiley & Sons, Inc., New York, N. Y., 1952)
8. Ashby, W. R. Design for an intelligence-amplifier. *Automata Studies*, 215-34 (Princeton University Press, Princeton, N. J., 1956)
9. Bard, P., and Mountcastle, V. B. Some forebrain mechanisms involved in expression of rage with special reference to suppression of angry behavior. *Research Publ. Assoc. Nervous Mental Disease*, **27**, 362-404 (1948)
10. Barron, D. H., and Matthews, B. H. C. The interpretation of potential changes in the spinal cord. *Am. J. Physiol.*, **92**, 276-321 (1938)
11. Batham, E. J., and Pantin, C. F. A. Inherent activity in the sea anemone. *J. Exptl. Psychol.*, **27**, 290-301 (1950)
12. Beach, F. A. Neural and chemical regulation of behavior. In *Biological and Biochemical Bases of Behavior*, 263-84 (University of Wisconsin Press, Madison, Wis., 1958)
13. Bernard, C. *Leçons sur la physiologie et la pathologie du système nerveux*, 2, Lecture 16 (J. B. Ballière et fils, Paris, France, 1858)
14. Beurle, R. L. Properties of a mass of cells capable of regenerating pulses. *Phil. Trans. Roy. Soc. London, Ser. B*, **240**, 55-94 (1956)
15. Bishop, G. Natural history of the nerve impulse. *Physiol. Rev.*, **36**, 376-99 (1956)
16. Bishop, G. H., and Clare, M. H. Sites of origin of electric potentials in striate cortex. *J. Neurophysiol.*, **15**, 201-20 (1952)
17. Blum, J. S., Chow, K. L., and Pribram, K. H. A behavioral analysis of the organization of the parieto-temporo-preoccipital cortex. *J. Comp. Neurol.*, **93**, 53-100 (1950)
18. Bradley, D. B., and Elkes, J. The effects of some drugs on the electrical activity of the brain. *Brain*, **80**, 77-117 (1957)
19. Broadbent, D. E. *Perception and Communication* (Pergamon Press, Inc., New York, N. Y., 1958)
20. Brodal, A. *The Reticular Formation of the Brain Stem: Anatomical Aspects and Functional Correlates* (Charles C Thomas, Publisher, Springfield, Ill., 1958)
21. Bruner, J. S. On perceptual readiness. *Psychol. Rev.*, **64**, 123-52 (1957)
22. Buck, J. B. *Bioluminescence in Renilla, in Relation to Nerve Net Physiology*. (Unpublished paper)
23. Burns, B. D. *The Mammalian Cerebral Cortex* (Edward Arnold & Co., London, England, 1958)

24. Bush, R. R., and Mostellar, F. A model for stimulus generalization and discrimination. *Psychol. Rev.*, **58**, 413-23 (1951)
25. Cannon, W. B. *Bodily Changes in Pain, Hunger, Fear, and Rage. An Account of Recent Researches into the Function of Emotional Excitement* (D. Appleton & Co., New York, N. Y., 1929)
26. *The Central Nervous System and Behavior. Transactions of the First and Second Conference, February 22-25, 1958 and 1959* (Josiah Macy, Jr. Foundation, New York, N. Y., 1959, 1960)
27. Chow, K. L. Effects of partial extirpations of the posterior association cortex on visually mediated behavior. *Comp. Psychol. Monographs*, **20**, 187-217 (1951)
28. Chow, K. L. Effects of temporal neocortical ablation on visual discrimination learning sets in monkeys. *J. Comp. Physiol. Psychol.*, **47**, 194-8 (1954)
29. Chow, K. L. Further studies on selective ablation of associative cortex in relation to visually mediated behavior. *J. Comp. Physiol. Psychol.*, **45**, 109-18 (1952)
30. Chow, K. L. Behavioral effects following destruction of some thalamic association nuclei in monkey. *A.M.A. Arch. Neurol. Psychiat.*, **71**, 762-71 (1954)
31. Colle, J., Gasteaut, H., and Dell, P. Correlation entre le système nerveux végétatif et le système de la vie de relation. *J. physiol. et pathol. gén.*, **44**, 415-557 (1952)
32. *Cybernetics: Circular Causal and Feedback Mechanisms in Biological and Social Systems: Transactions of the Seventh Conference, March 23-24, 1950* (Josiah Macy, Jr. Foundation, New York, N. Y., 1951)
33. Dempsey, E. W., Morison, R. S., and Morison, B. R. Some afferent diencephalic pathways related to cortical potentials in the cat. *Am. J. Physiol.*, **131**, 718-31 (1941)
34. Deutsch, J. A. A new type of behavior theory. *Brit. J. Psychol.*, **44**, 304-17 (1953)
35. Deutsch, J. A. A machine with insight. *Quart. J. Exptl. Psychol.*, **6**, 6-11 (1954)
36. Deutsch, J. A. A theory of insight, reasoning, and latent learning. *Brit. J. Psychol.*, **47**, 115-25 (1956)
37. Echlin, F. A., Arnett, V., and Zoll, J. Paroxysmal high voltage discharge from isolated and partially isolated human and animal cortex. *Electroenceph. and Clin. Neurophysiol.*, **4**, 147-64 (1952)
38. Elkes, J. Drug effects in relation to receptor specificity within the brain: some evidence and provisional formulation. In *Neurological Basis of Behavior (Ciba Foundation Symposium)*, 303-36 (Little, Brown & Co., Boston, Mass., 1958)
39. Estes, W. K. Theory of elementary predictive behavior: an exercise in the behavioral interpretation of a mathematical model. In *Mathematical Models of Human Behavior—Proceedings of a Symposium* (Dunlap and Associates, Inc., Stamford, Conn., 1955)
40. Estes, W. K. Toward a statistical theory of learning. *Psychol. Rev.*, **57**, 94-107 (1950)
41. Ettlinger, G., and Wegener, J. Somaesthetic alternation, discrimination and orientation after frontal and parietal lesions in monkeys. *Quart. J. Exptl. Psychol.*, **10**, 177-86 (1958)
42. Fulton, J. F. *Textbook of Physiology*, Chapt. 15 (W. B. Saunders Co., Philadelphia, Pa., 1955)

45. Galambos, R. Suppression of auditory nerve activity by stimulation of efferent fibers to cochlea. *J. Neurophysiol.*, **19**, 424 (1956)
46. Gelernter, H. L., and Rochester, N. Intelligent behavior and problem-solving machines. *IBM J. Research Develop.*, **2**, (1958)
47. Gerard, R. W., and Libet, B. The control of normal and "convulsive" brain potentials. *Am. J. Psychiat.*, **96**, 1125-53 (1940)
48. Gerard, R. W., and Young, J. Z. Electrical activity of the central nervous system of the frog. *Proc. Roy. Soc. (London)*, **122**, 343-52 (1937)
49. Gibson, J. J. Perception as a function of stimulation. In *Psychology: A Study of a Science; Study I. Conceptual and Systematic. Vol. I, Sensory, Perceptual, and Physiological Formulations*, 456-501 (McGraw-Hill Book Co., New York, N. Y., 1959)
50. Gibson, J. J. *The Perception of the Visual World* (Houghton Mifflin Co., New York, N. Y., 1950)
51. Gibson, J. J., and Gibson, E. J. Perceptual learning: differentiation or enrichment. *Psychol. Rev.*, **62**, 32-41 (1955)
52. Gloor, P. Electrophysiological studies on the connections of the amygdaloid nucleus in the cat. Part I: *EEG Clin. Neurophysiol.*, **7**, 223-42 (1955)
53. Gloor, P. Electrophysiological studies on the connections of the amygdaloid nucleus in the cat. Part II, *EEG Clin. Neurophysiol.*, **7**, 243-64 (1955)
54. Granit, R. Centrifugal and antidromic effects on ganglion cells of retina. *J. Neurophysiol.*, **18**, 388 (1955)
55. Granit, R. *Receptors and Sensory Perception* (Yale University Press, New Haven, Conn., 1955)
56. Green, E. J. A simplified model for stimulus discrimination. *Psychol. Rev.*, **65**, 56-73 (1958)
57. Green, J. D. The rhinencephalon and behavior. *Neurological Basis of Behavior (Ciba Foundation Symposium)*, 222-35 (Little, Brown & Co., Boston, Mass., 1958)
- 57a. Green, J. D., Clemente, C. D., and de Groot, J. Rhinencephalic lesions and behavior in cats. An analysis of the Klüver-Bucy Syndrome with special reference to normal and abnormal sexual behavior. *J. Comp. Neurol.*, **108**, 505-45 (1957)
58. Halstead, W. C. *Brain and Intelligence: A Quantitative Study of the Frontal Lobes* (University of Chicago Press, Chicago, Ill., 1947)
59. Harlow, H. F. The evolution of learning. In *Behavior and Evolution*, 251-68 (Yale University Press, New Haven, Conn., 1958)
60. Harris, G. W., Michael, R. P., and Schott, P. P. Neurological site of action of stilboestrol in eliciting sexual behavior. In *Neurological Basis of Behavior (Ciba Foundation Symposium)*, 236-54 (Little, Brown & Co., Boston, Mass., 1958)
61. Harris, J. D. Hearing. *Ann. Rev. Psychol.*, **9**, 47-70 (Annual Reviews, Inc., Palo Alto, Calif., 1958)
62. Hebb, D. O. Drives and the CNS (conceptual nervous system). *Psychol. Rev.*, **62**, 243-54 (1955)
63. Hebb, D. O. *The Organization of Behavior*. (John Wiley & Sons, Inc., New York, N. Y., 1949)
64. Hebb, D. O. *Textbook of Psychology* (W. B. Saunders Co., Philadelphia, Pa., 1958)

65. Henry, C. E., and Scoville, W. B. Suppression-burst activity from isolated cerebral cortex in man. *EEG Clin. Neurophysiol.*, **4**, 1-22 (1952)
66. Hume, D. M. Hypothalamic localization for the control of various endocrine secretions. In *Reticular Formation of the Brain (Henry Ford Hospital International Symposium)*, Chap. 11, 249-62 (Little, Brown & Co., Boston, Mass., 1958)
67. Hunter, W. S. The delayed reaction in animals and children. *Behavior Monographs*, **2** (1913)
68. Hurvich, L. M., and Jameson, D. Color vision. *Ann. Rev. Psychol.*, **11**, 99-130 (Annual Reviews, Inc., Palo Alto, Calif., 1960)
69. Ingvar, D. H. Electrical activity of isolated cortex in the unanesthetized cat with intact brain stem. *Acta Physiol. Scand.*, **33**, 151-68 (1955)
70. Jacobsen, C. F., and Nissen, H. W. Studies of cerebral function in primates. IV. The effects of frontal lobe lesions on the delayed alternation habit in monkeys. *J. Comp. Physiol. Psychol.*, **23**, 101-12 (1937)
71. Jacobsen, C. F., Wolfe, J. B., and Jackson, J. A. An experimental analysis of the frontal association areas in primates. *J. Nerv. Mental Diseases*, **82**, 1-14 (1935)
72. James, W. *Principles of Psychology*, **I**, 177-79, 489-90 (Dover Publications, Inc., New York, N. Y., 1950)
73. Jasper, H. H. Diffuse projection systems: the integrative action of the thalamic reticular system. *EEG Clin. Neurophysiol.*, **1**, 405-20 (1949)
74. Jasper, H. H. Recent advances in our understanding of ascending activities in the reticular system. In *Reticular Formation of the Brain (Henry Ford Hospital Symposium)*, Chapt. 15, 319-32 (Little, Brown & Co., Boston, Mass., 1958)
75. John, E. R., and Killam, K. F. Electrophysiological correlates of avoidance conditioning in the cat. *J. Pharm. Exptl. Therapeutics*, **125**, 252-74 (1959)
76. Karplus, J. P. Die Physiologie der Vegetativen Zentren. (Auf Grund Experimenteller Erfahrungen.) *Bumke und Foersters Handbuch Neurol.*, **2**, 402-75 (1937)
77. Karplus, J. P., and Kreidl, A. Gehirn und Sympathicus. I. Zwischenhirnbasis und Halsympathicus. *Arch. ges. Physiol. Pflügers*, **129**, 138-44 (1909)
78. Karplus, J. P. II. Ein Sympathicuszentrum im Zwischenhirn. *Arch. ges. Physiol. Pflüger's*, **135**, 401-16 (1910)
79. Karplus, J. P. III. Sympathicusleitung im Gehirn und Halsmark. *Arch. ges. Physiol. Pflüger's*, **143**, 109-27 (1912)
80. Kleene, S. C. Representation of events in nerve nets and finite automata. *Automata Studies*, 3-41 (Princeton University Press, Princeton, N. J., 1956)
81. Klüver, H. Visual functions after removal of the occipital lobes. *J. Psychol.*, **11**, 23-45 (1941)
82. Klüver, H., and Bucy, P. C. "Psychic blindness" and other symptoms following bilateral temporal lobectomy in rhesus monkeys. *Am. J. Psychol.*, **119**, 352-53 (1937)
83. Köhler, W. The present situation in brain physiology. *Am. Psychologist*, **13**, 150 (1958)
84. Kuffler, S. W., and Gerard, R. W. The small-nerve motor system to skeletal muscle. *J. Neurophysiol.*, **10**, 383-94 (1947)
85. Kuffler, S. W., and Hunt, C. C. The mammalian small-nerve fibers: a system for

- efferent nervous regulation of muscle spindle discharge. *Research Publ. Assoc. Nervous Mental Disease*, **30**, 24-47 (1952)
86. Lashley, K. S. Functional interpretation of anatomic patterns. *Research Publ. Assoc. Nervous Mental Disease*, **30**, 537-39 (1952)
87. Li, C. L., Cullen, C., and Jasper, H. H. Laminar microelectrode analysis of cortical unspecific recruiting response and spontaneous rhythms. *J. Neurophysiol.*, **19**, 131-43 (1956)
88. Libet, B., and Gerard, R. W. Control of the potential rhythm of the isolated frog brain. *J. Neurophysiol.*, **2**, 153-69 (1939)
89. Licklider, J. C. R. Three auditory theories. In *Psychology: A Study of a Science: Study I. Conceptual and Systematic. Vol. I. Sensory, Perceptual, and Physiological Formulations*, 41-144 (McGraw-Hill Book Co., New York, N. Y., 1959)
90. Lindsley, D. B. Emotion. In *Handbook of Experimental Psychology*, 473-516 (John Wiley & Sons, Inc., New York, N. Y., 1436 pp., 1951)
91. Livingston, R. B. Central control of afferent activity. In *Reticular Formation of the Brain (Henry Ford International Symposium)*, 177-86 (Little, Brown & Co., Boston, Mass., 1958)
92. MacLean, P. D. Contrasting functions of limbic and neocortical systems of the brain and their relevance to psycho-physiological aspects of medicine. *Am. J. Med.*, **4**, 611-26 (1958)
93. MacLean, P. D. The limbic system with respect to self-preservation and the preservation of the species. *J. Nervous Mental Diseases*, **1**, 1-11 (1958)
94. MacLean, P. D. Psychosomatic disease and the "visceral brain;" recent developments bearing on the Papez theory of emotion. *Psychosomat. Med.*, **11**, 338-53 (1950)
95. MacKay, D. M. The epistemological problem for automata. *Automata Studies*, 235-52 (Princeton University Press, Princeton, N. J., 1956)
96. McCulloch, W. A., and Pitts, W. A logical calculus of the ideas immanent in nervous activity. *Bull. Math. Biophys.*, **5**, 115-33 (1943)
97. Magoun, H. W. *The Waking Brain* (Charles C Thomas, Publisher, Springfield, Ill., 1958)
98. Mason, J. W. Visceral functions of the nervous system. *Ann. Rev. Physiol.*, **21**, 353-80 (1959)
- 98a. Matarazzo, J. D., Saslow, G., Matarazzo, R. G., and Phillips, J. S. Stability and modifiability of personality patterns manifested during a standardized interview. In *Psychopathology of Communication*, 98-125 (Grune & Stratton, Inc., New York, N. Y., 1958)
- 98b. Matarazzo, R. G., Matarazzo, J. D., Saslow, G., and Phillips, J. S. Psychological test and organismic correlates of interview interaction patterns. *J. Abnormal Social Psychol.*, **56**, 329-38 (1958)
99. Mettler, F. A. (Ed.) *Selective Partial Ablation of the Frontal Cortex* (Paul B. Hoeber, Inc., New York, N. Y., 1949)
100. Meyer, J. S. Studies of cerebral circulation in brain injury: IV: ischemia and hypoxemia of the brain stem and respiratory center. *EEG Clin. Neurophysiol.*, **1**, 83-100 (1957)
101. Miller, G. A., Galanter, E. H., and Pribram, K. H. *Plans and the Structure of Behavior*. In preparation, 1959.
102. Miller, G. A., Heise, G. A., and Lichten, W. The intelligibility of speech as a

- function of the context of the test materials. *J. Exptl. Psychol.*, **41**, 329-35 (1951)
103. Miller, N. E. Liberalization of basic S-R concepts: extensions to conflict behavior, motivation, and social learning. In *Psychology: A Study of a Science: Study I. Conceptual and Systematic. Vol. II. General Systematic Formulations, Learning, and Special Processes*, 196-292 (McGraw-Hill Book Co., New York, N. Y., 1959)
104. Milner, B. Psychological defects produced by temporal lobe excision. *The Brain and Human Behavior (Research Publ. Assoc. Nervous Mental Disease)*, 244-57 (1958)
105. Milner, P. M. The cell assembly: Mark II. *Psychol. Rev.*, **64**, 242-52 (1957)
106. Minsky, M. L. Some universal elements for finite automata. *Automata Studies*, 117-28 (Princeton University Press, Princeton, N. J., 1956)
107. Mishkin, M. Visual discrimination performance following partial ablations of the temporal lobe: II. Ventral surface vs. hippocampus. *J. Comp. Physiol. Psychol.*, **47**, 187-93 (1954)
108. Mishkin, M., and Pribram, K. H. Analysis of the effects of frontal lesions in monkeys: I. Variations of delayed alternation. *J. Comp. Physiol. Psychol.*, **48**, 492-95 (1955)
109. Mishkin, M., and Pribram, K. H. Analysis of the effects of frontal lesions in monkeys: II. Variations of delayed response. *J. Comp. Physiol. Psychol.*, **49**, 36-40 (1956)
110. Mishkin, M., and Pribram, K. H. Visual discrimination performance following partial ablations of the temporal lobe: I. Ventral vs. lateral. *J. Comp. Physiol. Psychol.*, **47**, 14-20 (1954)
111. Morgan, C. T. Physiological theory of drive. In *Psychology: A Study of a Science. Study I. Conceptual and Systematic. Vol. I. Sensory, Perceptual, and Physiological Formulations*, 664-72 (McGraw-Hill Book Co., New York, N. Y., 1959)
112. von Neumann, J. Probabilistic logics and the synthesis of reliable organisms from unreliable components. *Automata Studies*, 43-98 (Princeton University Press, Princeton, N. J., 1956)
113. Newell, A., Shaw, J. C., and Simon, H. A. Elements of a theory of human problem solving. *Psychol. Rev.*, **65**, 151-66 (1958)
114. Obrist, W., Kraft, M., and Pribram, K. H. The effect of cortical implants of aluminum hydroxide on retention and learning of visual discrimination in monkeys. *J. Comp. Physiol. Psychol.*, (In press)
115. Olds, J. High functions of the nervous system. *Ann. Rev. Physiol.*, **21**, 381-402 (1959)
116. Pribram, K. H. The intrinsic system of the forebrain: an alternative to the concept of cortical association areas. In *Handbook of Physiology*, **II**, (McGraw-Hill Book Co., New York, N. Y., in press)
117. Pribram, K. H. Comparative neurology and the evolution of behavior. In *Behavior and Evolution*, 140-64 (Yale University Press, New Haven, Conn., 1958)
118. Pribram, K. H. Interrelations of psychology and the neurological disciplines. In *Psychology: A Study of a Science: Study II. Empirical Substructure and Relations with Other Sciences. Vol. IV. Biologically Oriented Fields: Their Place in Psychology and in Biological Science* (McGraw-Hill Book Co., New York, N. Y., in press)

119. Pribram, K. H. Neocortical function in behavior. *Biological and Biochemical Bases of Behavior* (Harlow, H. and Woolsey, C., Eds., University of Wisconsin Press, Madison, Wis., 1958)
120. Pribram, K. H. On the neurology of thinking. *Behavioral Science*, **4**, 265-87 (1959)
121. Pribram, K. H. Toward a science of neuropsychology (method and data). In *Current Trends in Psychology and the Behavioral Sciences*, 115-42 (University of Pittsburgh Press, Pittsburgh, Pa., 1954)
122. Pribram, K. H., and Kruger, L. Functions of the "olfactory brain." *Ann. N. Y. Acad. Sci.*, **58**, 109-38 (1954)
123. Pribram, K. H., and Mishkin, M. Analysis of the effects of frontal lesions in monkeys: III. Object alternation. *J. Comp. Physiol. Psychol.*, **49**, 41-5 (1956)
124. *Progress in Neurobiology: III. Psychopharmacology: Pharmacologic Effects on Behavior* (Harper Brothers, New York, N. Y., 1958)
125. Ranson, S. W., Fisher, C., and Ingram, W. R. Hypothalamic regulation of temperature in the monkey. *A.M.A. Arch. Neurol. Psychiat.*, **38**, 445-66 (1937)
126. *Reticular Formation of the Brain (Henry Ford Hospital International Symposium)* (Little, Brown & Co., Boston, Mass., 1958)
127. Riggs, L. A. Vision. *Ann. Rev. Psychol.*, **9**, 19-46 (Annual Reviews, Inc., Palo Alto, Calif., 1958)
- 127a. Rochester, N. Tests of a cell assembly theory of the action of the brain, using a large digital computer. *IRE Trans. on Inform. Theory, PGIT-2*, **3** (1956)
128. Rose, J. E., and Woolsey, C. N. Organization of the mammalian thalamus and its relationships to the cerebral cortex. *EEG Clin. Neurophysiol.*, **1**, 391-404 (1949)
129. Rosenblatt, F. The perceptron: a probabilistic model for information storage and organization in the brain. *Psychol. Rev.*, **65**, 386-408 (1958)
130. Rosvold, H. E. Physiological psychology. *Ann. Rev. Psychol.*, **10**, 415-54 (Annual Reviews, Inc., Palo Alto, Calif., 1959)
131. Rosvold, H. E., Mirsky, A. F., and Pribram, K. H. Influence of amygdectomy on social interaction in a monkey group. *J. Comp. Physiol. Psychol.*, **47**, 173-78 (1954)
132. Scheibel, M. E., and Scheibel, A. B. Structural substrates for integrative patterns in the brain stem reticular core. In *Reticular Formation of the Brain (Henry Ford Hospital International Symposium)*, 31-38 (Little, Brown & Co., Boston, Mass., 1958)
133. Schreiner, L., and Kling, A. Behavioral changes following rhinencephalic injury in cat. *J. Neurophysiol.*, **16**, 643-59 (1953)
134. Scherer, I. W., Winne, J. F., and Baker, R. W. Psychological changes over a three-year period following bilateral prefrontal lobotomy. *J. Consulting Psychol.*, **19**, 291-98 (1955)
135. Schwartzbaum, J. S. Changes in reinforcing properties of stimuli following ablation of the amygdaloid complex in monkeys. *J. Comp. Physiol. Psychol.* (In press)
- 135a. Schwartzbaum, J. S., and Pribram, K. H. The effects of amygdectomy in monkeys on transposition of response along a brightness continuum. *J. Comp. Physiol. Psychol.* (In press)

136. Sherrington, C. C. *The Integrative Action of the Nervous System* (Yale University Press, New Haven, Conn., 1947 ed., 1906)
137. Sholl, D. A. *The Organization of the Cerebral Cortex* (John Wiley and Sons, Inc., New York, N. Y., 1956)
139. Skoglund, C. R. *Acta Physiol. Scand.*, **14**, Suppl. 47 (1947)
141. Sperry, R. W., Miner, N., and Meyers, R. E. Visual pattern perception following subpial slicing and tantalum wire implantations in the visual cortex. *J. Comp. Physiol. Psychol.*, **48**, 50-58 (1955)
142. Stamm, J. S. The function of the median cerebral cortex in maternal behavior of rats. *J. Comp. Physiol. Psychol.*, **87**, 77-88 (1955)
143. Stamm, J. S., Pribram, K. H., and Obrist, W. The effect of cortical implants of aluminum hydroxide on remembering and learning. (Presented at Annual meeting of American EEG Society, Atlantic City, N. J., June 13, 1958)
144. Stellar, E. The physiology of motivation. *Psychol. Rev.*, **61**, 5-22 (1954)
145. *Symposium on Brain Stimulation* (University of Houston Press, Houston, Texas, in press)
146. A Symposium on Dendrites. *EEG Clin. Neurophysiol., Suppl. 10* (November, 1958)
147. Teitelbaum, P. Sensory control of hypothalamic hyperphagia. *J. Comp. Physiol. Psychol.*, **48**, 156-63 (1955)
148. Uttley, A. M. Conditional probability machines and conditioned reflexes. *Automata Studies*, 253-75 (Princeton University Press, Princeton, N. J., 1956)
149. Uttley, A. M. Temporal and spatial patterns in a conditional probability machine. *Automata Studies*, 277-83 (Princeton University Press, Princeton, N. J., 1956)
150. Wade, M. Behavioral effects of prefrontal lobectomy, lobotomy and circumsection in the monkey (Macaca Mulatta). *J. Comp. Neurol.*, **96**, 179-207 (1952)
151. Walter, W. G. *The Living Brain* (W. W. Norton & Co., Inc., New York, N. Y., 1953)
152. Weiskrantz, L. Behavioral changes associated with ablation of the amygdaloid complex in monkeys. *J. Comp. Physiol. Psychol.*, **49**, 381-94 (1956)
153. Whitfield, I. C. Sensory mechanisms and sensation (Presented at Symposium on the Mechanization of Thought Processes, National Physical Laboratory, Teddington, Middlesex, England, November 24-27, 1958); in *Proceedings of the Symposium* (His Majesty's Stationery Office, London, England, in press)
154. Wikler, A. *The Relation of Psychiatry to Pharmacology* (The Williams & Wilkins Co., Baltimore, Md., 1957)

As this review is going to press, Professor A. Luria comments in response to a preview, "Too bad you all do not use Russian literature!" He suggests especially articles in the journal *Questions of Psychology* and: (a) On feedback, A. D. Beznstein, "Problems of Co-ordination and Localization," *Arch. Biol. Sci.*, **38**, N7, 1955, and *On the Construction of Movements* (Med. Press Publishing House, Moscow, 1947). (b) On reinforcement, P. K. Anokhin's mechanisms of an "action acceptor," *Problems of the Center and the Periphery in Physiology of the Nervous System* (Gorki State Publishing House, 1935); *Problems of Higher Nervous Activity* (Acad. Med. Sci. Publishing House, Moscow, 1958); *Inner Inhibition as a Physiological Problem* (Med. Press Publishing House, Moscow, 1958). (c) On disposition, D. N. Usnadze, *Experimental Investigations of Set* (Review of 25 years of work).

BEHAVIOR GENETICS¹

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A chapter on behavior genetics is new to the *Annual Review of Psychology*. This creates certain problems with respect to the time span which should be covered. Some papers in this area have previously been reviewed in chapters dealing with comparative or experimental psychology. The nearest approach to a treatment of behavior genetics was Kallman & Baroff's (64) review of behavior abnormalities in 1955, which emphasized the inheritance of mental disorder.

An article in the *Annual Review*, whatever the time span it covers, should fairly represent contemporary interest as distinguished from historical trends. The year 1954 has been selected as a starting point, because, in a relatively small area such as behavior genetics, a five-year period permits a representative sampling of present-day interests. Furthermore, this choice of date allows the inclusion of a major summarizing volume, *Genetics and the Inheritance of Integrated Neurological and Psychiatric Patterns* (57).

BOOKS

As yet there is no book which systematically covers the field of behavior genetics. During the past five years a number of volumes have appeared, however, which have more than routine significance for this area. Perhaps the most important is the previously mentioned volume, which was the outcome of an annual conference of the Association for Research in Nervous and Mental Disease. A number of individual contributions to this symposium are referred to in more detail later in this chapter. The volume as a whole, however, gives a fairly comprehensive account of various approaches to the physiological genetics of behavior. Many of the authors are concerned with the pathways through which genes produce behavioral variation. Errors of metabolism, such as phenylketonuria, and anatomical defects find a prominent place, although some attention is given to the inheritance of intelligence (Thompson), the functional psychoses (Kallman), and genetics and adaptability (Glass). Another group of chapters deals with problems of behavior development, the area usually called genetic psychology. It is good to find such papers in juxtaposition to papers on heredity, for the fields of psychological genetics and genetic psychology have sometimes seemed to pull in opposite directions.

Two books come to grips with the problem of heredity and behavior as part of a treatment of the general subject of individual differences. Tyler's *The Psychology of Human Differences* (122) devotes a brief chapter to the hereditary basis of individual differences. Although the results of twin studies

¹ The survey of the literature pertaining to this review was completed in April, 1959.

are criticized on technical grounds, Tyler believes that the consistency of the evidence on similarities of identical twins is proof that genetics plays an important part in the production of individual differences in human behavior. The environment of both members of one-egg twin pairs is undoubtedly more similar than that of the members of two-egg pairs, but this does not seem large enough to account for the observed greater similarities of the one-egg pairs. Anastasi (5) has published a third edition of the well-known *Differential Psychology*. This book contains no separate chapter on heredity, but two long and comprehensive chapters deal with heredity and environment interactions. Anastasi gives an excellent account of the types of confusion which have centered about the nature-nurture issue. Students exposed to this text should be more sophisticated than some of their predecessors. In the earlier editions, this text might have been classified as slightly environmentalist. The present edition, though still highly critical of naive hereditarian views, strikes a very sound middle ground. It is perhaps one of the best sources for critical consideration of methodological problems.

The relationships of genetics to behavior are considered from the viewpoint of a biologist in Scott's *Animal Behavior* (104). Emphasis is placed on experimental evidence from animals, and sex differences in behavior are taken as a model of the inheritance of psychological characteristics. Adaptiveness of behavior is viewed as an outcome of selection operating on genetic mechanisms. The biologists' viewpoint complements, rather than conflicts with, that of the psychologist.

Two other books should also be mentioned here. One, *Behavior and Evolution* (94), is the result of two conferences sponsored jointly by the American Psychological Association and the Society for the Study of Evolution. Although genetics is possibly the biological science currently most concerned with the dynamics of evolution, most of the chapters in this book deal with the classical method of comparisons between phyletic groups, the end results of the evolutionary process. Some of the contributors (Caspari, Harlow, Pitendrigh), however, have dealt with the problem of the interactions between behavioral variation and selection pressures which could lead to progressive modification of behavior patterns. The second volume is the report of the Milbank Conference on *The Nature and Transmission of the Genetic and Cultural Characteristics of Human Populations* (80). In contrast with the Association for Research in Nervous and Mental Disease contributors, the Milbank authors show less concern with the mechanisms by which genes influence behavior and place more emphasis on heredity as a source of psychological differences within and between populations.

Finally, in this introduction it is interesting to compare the emphasis placed upon behavioral genetics in different scientific disciplines by counting the number of contributed papers in this category in three recent International Congresses, the First International Congress of Human Genetics (Copenhagen) (38), the Fifteenth International Congress of Psychology (Brussels) (37), and the Tenth International Congress of Genetics (Montreal)

(117). The Human Genetics Congress produced 21 papers in the field, 5 on endogenous psychoses, 5 on mental deficiency, and 11 on normal and abnormal behavior patterns. Some of the latter, however, would not be included in the stricter definitions of the field of behavior genetics. The Psychological Congress and the Genetics Congress produced two papers each. It may be concluded that activity in behavior genetics is still predominantly directed at practical human problems. Nevertheless, a steady output of experimental papers continues.

THEORY AND METHODS

Dobzhansky (30) has dealt exhaustively with the relationship between genes and behavioral characters. Nature is not fatalistic, but, in a sense, our bodies and hence our phenotypes are by-products of the self-copying of genes. In this sense all characters might be considered as 100 per cent hereditary [cf. (47) for a similar view]. Genes must determine characters such as intelligence, since different genotypes develop differently in the same environment. But the intelligence of two individuals of different genotypes might be exactly the same provided their environments were different. Dobzhansky believes that human development is unique since it is determined by three factors instead of the usual two—environment, heredity, and culture. To this reviewer, it seems more parsimonious to consider culture as a unique form of environment which shows progressive evolutionary modification. It is interesting to contrast Dobzhansky's view of the uniqueness of man with Harlow's (51a) espousal of a very close physical relationship between man and other primates. We are not yet rid of arguments on the continuity or discontinuity of man and beast, though the area of disagreement has shifted from biology to psychology.

In a presidential address, Anastasi (6) has gone somewhat beyond her textbook in outlining a program for research in the nature-nurture area. Historically, the first question asked in this field was, "Which determines a particular trait?" Later interest shifted to "How much does each contribute to a trait?" but the focus should go on to "How does a trait develop?" One can agree with much of this analysis without conceding that the question "How much?" is obsolete. The kinds of questions one can ask about nature and nurture with respect to individuals are different from those one can ask with respect to populations. For an individual, the question "How much?" has no significance, since all traits may be logically considered as completely hereditary or completely environmental. In dealing with populations, however, the contribution of heredity to total variance is still a useful object of inquiry, though with increased sophistication we have come to see that the answer to "How much?" is not a universal constant.

Two papers have dealt with the contribution of factor analytic theory to the definition of traits which might be useful for genetic analysis. Royce (100) has pointed out a similarity between the multiple factor theory of psychology and the multiple factor theory of genetics. In the diagrams which

accompany his article, separate groups of genes are assigned to each factor of intelligence, such as, for example, the ability to perceive spatial relationships and memory. Such isomorphism of genetic and psychological elements has not been proved and seems unlikely on neurological principles. Thompson (119) in dealing with this problem has gone back to the genetic meaning of correlations. Two phenotypic characters may be correlated because they are dependent upon a common gene, upon two genes present in the same chromosome, upon genes which happen to be present in the same populations or because of mutual dependence upon an environmental factor which has no genetic significance. Without incorporating some test of genetic meaning it is logically impossible for factor analysis to lead directly to biological factors which are genetically simple. Thompson suggests that Eysenck's "Criterion Analysis" might prove a useful technique, though it has not been adequately tested. The problem of defining behavioral phenotypes in a form best suited to genetic analysis deserves more attention. Most investigators adopt measures which intuitively seem to have meaning for them.

The use of split-litter technique in psychological research has been critically reviewed by Ross, Ginsburg & Denenberg (98). They warn against the facile assumption that this method is a good control for genetic variability. Whether it is or not will depend upon the breeding structure of the population sampled. In actual practice, split-litter technique is probably more useful for the control of environmental factors common to litters than for the control of genetic variability. The evidence from such areas as endocrinology and pharmacology (78) indicates that efficiency of bioassay is markedly improved by use of littermate control.

A technical advance particularly suitable for behavior genetic studies with small organisms, such as fruit flies, has been described by Hirsch & Tryon (56). Their procedure of mass screening reliably classifies every individual's behavior without handling or observing it individually. Such a method is particularly useful in selection experiments in which large numbers of individuals should be tested in order to proceed efficiently. Another technique new to behavior genetics is the manipulation of chromosomes which can be identified reliably by marker genes (54). This permits evaluation of the effect of a specific chromosome upon variability of a specific behavior measure. Techniques of this sort bring behavior genetics close to the model of ordinary experimental psychology, in which the chromosomes are independent variables under the control of the experimenter. Unfortunately, they are better adapted to *Drosophila* than to mammals, in whose behavior there is greater interest.

BEHAVIOR GENETICS OF INVERTEBRATES

Hereditary mechanisms are, of course, similar in vertebrates and invertebrates. The advantage of invertebrates for behavior genetics lies in a more rapid succession of generations. The behavior of invertebrates appears stereotyped, and it seems reasonable to assume that the correlation between geno-

type and behavioral phenotypes may be higher than in most vertebrates. Arguments for the use of the rich genetic variability available in the fruit flies have been summarized by Hirsch (54).

A small, but varied, group of papers have utilized the fruit flies and a scattering of other insect species. Other classes and phyla are still neglected. Habitat preference has been studied in a series of strains of *Drosophila melanogaster* (126). Differences with respect to light, temperature, and humidity optima were established. Since the strains differed at loci other than the one which gave them their name, it is probable that habitat choice is affected by a polygenic system. Courtship and mating of fruit flies have continued to attract attention, since selective mating based on behavioral differences must have evolutionary significance. Earlier studies in this area proved that selective mating existed, but did not determine its behavioral basis. In a yellow strain of *D. melanogaster*, the reduction of "sex drive" in males can apparently be attributed to the *y* gene itself (8, 9). No such effect was demonstrated in females. Indeed, females of well-established *y* bearing stocks were found to be unusually receptive, probably because highly receptive females will be positively selected when only low-drive males are available. In another species, *Drosophila subobscura*, the side-to-side courtship movements of the female probably confer selective advantage on more vigorous males (111). These active movements interfere with copulation, and hence discriminate against the less athletic males. Both of these studies emphasize the important role of male vigor, and de-emphasize discriminative choice by either sex. However, there is evidence that under some circumstances female drosophilae do discriminate genetically different males, and that assortative mating results from this (116).

Experiments on genetic selection for behavioral traits were not common during the half-decade considered in this review, and two of these employed *D. melanogaster*. Apparently scientists today are in too much of a hurry to carry out selection studies with the slower breeding laboratory mammals. Hirsch & Boudreau (55) developed strains of flies showing strong and weak phototaxis. Both phototaxis and geotaxis in different races of *D. melanogaster* were observed by Dürrwachter (32). He reared subjects in both darkness and light, and claims to have demonstrated progressive changes in the strength of the phototactic response.

Crickets, moths, and honeybees have also served as subjects for behavior genetics. The heritability of specialized courtship and mating behavior patterns has been demonstrated by von Hörmann (58) in crosses between two closely related European crickets. The separate parts of the pattern follow different patterns of inheritance in the hybrids. The results indicate that the components are not dependent upon a single central mechanism, but that each has its own set of genetic determiners. Similar independence of the genetic control of components of complex behavior has been shown by two other workers. Food plant selection and cocoon structure were studied in the hybrid larvae of two moths, *Callosamia promethea* and *C. angulifera*, by

Haskins & Haskins (52). Food preferences of the F_1 hybrids were almost completely those of the *C. angulifera* parent, but the cocoon structures were mostly intermediate with a scattering of both parental types.

A particularly interesting study of honeybees also disclosed the genetic separation of two components of a well-integrated pattern. One of the mechanisms by which this species resists the disease, American foul brood, is the opening by the workers of the cells containing a diseased larva and its removal from the hive. This has been called "hygienic behavior" by Rothenbuhler (99). This investigator crossed a strain which showed the behavior with a disease-susceptible strain which did not. In the F_1 hybrids no hygienic behavior was evident, but backcrosses to the hygienic strain produced equal numbers of workers who (a) showed the complete pattern, (b) opened cells, but did not remove larvae, (c) removed larvae only after the cell was artificially uncapped, and (d) neither uncapped cells nor removed larvae. These findings suggest that uncapping and removal behavior are inherited as monogenic recessive characters.

BEHAVIOR GENETICS OF VERTEBRATES

Sexual Behavior.—The inheritance of sexual behavior has been studied from several aspects. Clark, Aronson & Gordon (25) hybridized platyfish and swordtails, which apparently do not interbreed in nature although they do so readily in aquaria. The courtship patterns of the males were special objects of interest and it was shown that the F_1 , F_2 , and backcross generations behaved in a manner predictable from their genetic origin. The inheritance of the special courtship movements did not follow simple Mendelian ratios, however, and the genetic mechanisms must be complex. In the F_2 , segregation of genes affecting structure gave rise to individuals who phenotypically resembled either swordtail or platyfish grandparents, but the morphological characteristics were not correlated with behavior. In a similar fashion, the courtship patterns of interspecific hybrids of birds, greenfinch, goldfinch, and canary have been studied by Hinde (53). Patterns normally appearing in only one parent species appear less intensely in the F_1 ; patterns which are somewhat similar in both parent species appear in intermediate form; and similar patterns which only vary in frequency in the parents appear in the hybrids at an intermediate frequency. Hinde argues that the evidence favors a homology of the genetic determinants of behavior in the three species. If the similar phenotypes were based on different genotypes, the behavioral development of the hybrids would probably be disrupted, since the two systems would not mesh smoothly.

A series of studies on sexual behavior in guinea pigs has been carried out at the University of Kansas under the general direction of Young. In these experiments the complex interaction of genes, hormones, and experiential factors has been thoroughly investigated. Such research is based on the concept that behavior development is an interaction between a genotype and a

specific environment, and that one task of behavior genetics is the quantitative evaluation of the effect of various combinations of factors. The basic studies (49, 123) showed that inbred strains and genetically heterogeneous strains differed significantly with respect to strength of "sex drive." As in yellow strain *Drosophila*, an inverse relationship was found in the sex scores of males and females in the same strain (49). The oxygen consumption of males of the more sexually vigorous strain is high compared with less vigorous strains, but within strains the correlation of sexual activity and metabolism rate is insignificant (91). This observation suggests that energy output places an upper limit upon sexual activity, but does not determine it directly. Type of rearing has considerable influence upon later sexual activity; males with a minimum of contact with other animals generally have low sex behavior scores as adults (50, 124). The critical period for acquiring contactual experience lies between 10 and 25 days for heterogeneous strains, but is later than 25 days for the inbred strains. The depressing effects of isolation are confined to the period in which sexual response patterns are being organized. These authors follow Beach's hypothesis of dual components of mating behavior. The capacity for sexual performance, a matter of response organization, is primarily dependent upon social experience. The second component, sexual excitability, seems unrelated to social experience and more directly under genetic control. Just as the effects of experience upon sexual behavior differs with genotypes, so do the effects of hormones. Strains with low sex drive are not raised to a high level by large doses of androgen (92).

The family intercorrelation method has been used to study genetic effects upon the sex drive of cockerels (130). By using a number of sire families with each sire mated to several dams, it is possible to obtain measurements of the contribution of both dam and sire to performance. In this study, differences between sire families were significant, but those between dams (within a sire family) were not. Some evidence was found that the sex behavior differences were in this case positively correlated with androgen production as measured by comb height. Crosses using high-libido and low-libido males also gave evidence for the heritability of sexual activity (129).

Sexual selection, and indirectly sexual behavior, has been studied in mice by a method somewhat analogous to that reported in fruit flies (74, 81). Strain ST males, competing with CBA males for receptive females, sired six times as many litters as their competitors. These results are attributed to the dominance hierarchy setup between males, not to choice on the part of the female.

Other specialized behavior patterns.—Several studies have dealt with the heritability of rather specialized behavior patterns which show considerable individual variation. Curtis (28) made quantitative measurements of circling behavior in inbred strains selected for this characteristic. Circling and waltzing mice are well-known, but as a rule this behavior is found to depend upon specific genes which affect the vestibular system at one or more levels.

Circling in Curtis's strains is possibly under polygenic control, though the genetic analysis was not conclusive. Although the circling is clearly affected by genotype, the phenotypic expression of the trait is strongly modified by the conditions of testing.

The eating behavior of a rather remarkable mutant mouse characterized by extreme obesity has received some attention. The condition is inherited as a monogenic recessive. Fuller & Jacoby (44) found that both normal and obese mice responded similarly to changes in the palatability of food, and that, in general, obese mice were not characterized by a higher hunger drive. However, over a period of days, normal mice adjusted to unpalatable or to palatable and high-caloric diets on the basis of caloric need, while obese mice made such adjustments less effectively. The authors concluded that a central hunger-control mechanism was defective in their obese subjects. These results are consistent with the feeding cycles which Anliker & Mayer (7) demonstrated in a bar-pressing apparatus. A 24-hour cycling is evident in normal mice, but the genetically obese animals eat periodically throughout the day and do not show typical satiation. Rather remotely allied to these experiments on genetic factors and ingestive behavior is a study of free alcohol intake in successive generations of mice (82). The experiment does not really test a genetic hypothesis, but it has been offered as evidence for Williams' (128) genotrophic theory of alcoholism.

A series of studies by Stamm (113, 115) has dealt with strain differences and heritability of hoarding in rats. Black-hooded, brown-hooded, and Irish rats showed significant differences in the time of onset of hoarding and the number of pellets transported. F_1 hybrids hoarded about as much as the high-hoarding black-hooded parents, and backcrosses of the F_1 to Irish parents were intermediate. Stamm reported that his results were consistent with a single gene difference between the strains, but the genetic experiment is not extensive enough to really prove this. The F_1 s were used in a test of the hypothesis that hoarding is positively correlated with dominance, but the predicted association was not found (114).

Temperament.—Strain differences in emotionality continue to be of considerable interest in behavior genetics. Broadhurst has utilized the familiar Hall defecation test for emotionality in the rat. After considering situational factors (13) and experiential factors (14) affecting the results, Broadhurst concluded that the test could be used with considerable reliability in behavior genetics. Significant differences were found between a number of inbred rat strains, some of which were the same as those used by Stamm in his study of hoarding (15). Broadhurst (16) has also developed by selection strains of emotionally reactive and nonreactive subjects. These stocks were used to test a prediction that the emotional subjects should show less alternation behavior than nonemotional because of a greater tolerance of reactive inhibition (109), but the hypothesis was not confirmed.

Various activity measures have been the most commonly used tests of temperament. Wild and domesticated Norway rats were compared in spon-

taneous activity by Richter & Rice (89), who found that fasting increased the activity of wild rats much more than domestic. Richter & Uhlenhuth (90) found the activity of wild rats less affected by gonadectomy. The generality of behavior-physiology correlations obtained in experiments with domesticated laboratory animals is certainly questionable. Laboratory strains of mice and rats have also been compared on many types of activity tests. Kish & Antonitis (70) found that C57BL/6 mice have a significantly higher operant rate of platform depression than BALB/c's. McClearn (76) observed six mouse strains on four tests, each test measuring some aspect of exploratory behavior. Strain differences on all tests were significant, and the concordance between them was high enough to indicate that some common factor was measured. F₁ crosses were made between two of the most different strains and tests were repeated on the hybrids. The results suggested to McClearn that so-called exploratory behavior is made up of at least two subcharacters which behave differently in the hybrids. This is an interesting hypothesis. It should be noted, however, that the tests in which the hybrids were intermediate involve sampling of behavior over a period of time; the tests which showed "dominance" involved a single major output of activity. The difference in phenotypic ratios may be a function of the tests rather than of internalized subcharacters within the organism. Physiologically, the hybrids may be intermediate with respect to a single activity factor, but the expression of this factor will differ on tests which give an essentially continuous distribution of scores and on those which require that the subject exceed a threshold in order to receive a score.

Inbred strains of rats from the University of Miami stocks were subjects in another study of exploratory behavior (20). Hooded rats explored more than either Albino-Fischer or Blacks. There was a slight indication that the Blacks were more likely to choose three successive unlike arms in the test Y-maze, which might indicate more rapid satiation of an "exploratory drive."

Breed differences in the activity of dogs during routine weekly weighing were reported by Scott & Charles (105). This paper is particularly interesting because of its theoretical formulations. Each breed follows a characteristic developmental path, a process which may be called canalization. Training tends to fix responses, but the direction of the canalization appears to be a function of heredity. By the interaction of training and genetic determinants, the authors claim that a relatively small inherited initial difference can be magnified, as development once started along divergent courses leads to extremely different end products. These views have also been applied to a wider sampling of forms of behavior (106). Somewhat similar heredity-environment interactions on complex behavior were reported by Freedman (41, 42). Subjects from four breeds were reared by either "indulgent" or "disciplinary" methods. The effects of his differential procedures were tested by a "conscience" test, in which subjects who had been punished by the experimenter for attempting to eat were observed through a window after the experimenter

left the room. In two breeds, Shetland sheepdogs and basenjis, method of rearing had no significant effect upon the test. Indulged beagles and wire-haired terriers refrained from eating for a longer period than did their disciplined sibs. Freedman's work was undertaken with the avowed intent of testing the effects of different systems of child rearing. He emphasizes a point made in other studies, that developmental laws apply to particular organisms and that genetic differences play a major role even within a single species.

The study of temperamental differences between dog breeds extended beyond the laboratory in the work of Mahut (77), who observed her subjects in the homes of their owners. Timidity was rated in a test for irrational fears when dogs were suddenly presented with such objects as a mechanical snake, a musical top, and a Hallowe'en mask placed on the owner. Breed differences were highly significant and the author believes she has demonstrated an important hereditary effect upon emotional behavior which overrides the fact that her subjects must have had quite different life experiences. She believes it unlikely that her results can be explained by the hypothesis that particular kinds of owners select particular breeds and impose their own stereotype of appropriate dog behavior upon their canine cohabitants. This reviewer, who has owned several breeds of dogs, is inclined to agree.

Psychological literature on audiogenic seizures has decreased in volume as the problem seems to have become one of physiology and biochemistry. Frings, Frings & Hamilton (43) reported on convulsion responses in animals selected for both low and high susceptibility. Their results indicated that the F₁ hybrid between the two selected stocks was quite variable and most of the individuals could be classified in the high- or low-susceptibility classes, while relatively few were intermediate. They suggest that there are two stable developmental equilibria, a concept reminiscent of the threshold hypothesis of Scott & Charles (105). Audiogenic seizures were also used as a test of emotionality as related to free-choice alcohol consumption (29). This experiment was designed as a partial test of Williams' genotrophic theory of alcoholism. It was reasoned that susceptibility to audiogenic seizures might be related to the same kinds of genetic biochemical blocks which Williams postulates as etiological factors in alcoholism. As predicted, rats with high seizure susceptibility were also the heavy alcohol imbibers.

The inheritance of aggression has been reviewed by Scott (103), who places considerable emphasis upon physiological factors, particularly male sex hormones. Experimental studies have been conducted predominantly with inbred strains of mice. Fredericson & Birnbaum (39) found that BALB/c mice tended to share a single piece of food while C57BL mice would fight vigorously over it. When, however, the normally passive BALBs were paired with the aggressive C57BLs, a vigorous battle broke out. In a later study (40), it was found that trained C57BLs fought much less after a female mouse was introduced into the fighting arena. BALB/c males were less distractable and continued to fight vigorously in the presence of the opposite sex. These authors interpret the results in terms of differential strength of sexual and

aggressive motivation. The same two strains were used by Bauer (10) in a study of the effect of types of rearing, social or isolated, upon attacking behavior in later life. The C57BLs were, as in other investigations, more aggressive, but the mode of rearing had little effect upon fighting behavior.

Somewhat similar in concept was the study of King & Eleftheriou (68) on the effects of early handling upon adult behavior in two subspecies of deermice, *Peromyscus maniculatus*. These workers specifically hypothesized that handling, in their experiment accomplished by a mechanical device, would be more effective with the more docile subspecies, *Peromyscus gracilis*, than with the wilder *Peromyscus bairdii*. This hypothesis was not completely confirmed but they did find a highly significant subspecific treatment interaction, and concluded that the effects of early handling and other special experiences do vary according to the genotype of the animal so exposed.

Perhaps the most important conclusion from this whole set of diverse papers is that investigators are not now studying so much the inheritance of emotional characters as the effects of the genotype upon developmental history of emotional behavior. Such a rephrasing of the problem eliminates a host of semantic and interpretive problems. It is probable that strain differences can be demonstrated in almost any measure of emotionality which is systematically investigated. Such results by themselves are not of great significance, since the point has already been adequately confirmed. Strain differences are merely a starting point for detailed studies of behavioral development and as sources of biochemical, anatomical, and physiological variations, which can be correlated with behavior.

Social behavior.—In a broad sense, sexual and aggressive behavior are considered social, since they involve more than one organism. In the more limited definition of this section, however, social behavior is considered to be an attribute of groups rather than individuals. A group does not have a single genotype, but its organization is affected by the genotypes of its members. The three studies cited here were carried out at the Roscoe B. Jackson Memorial Laboratory. In a comparative study of dog breeds, King (66) found that basenjis formed more rigidly organized social hierarchies than cocker spaniels, and that their organized groups were less open to strangers. These results are in agreement with those of Pawlowski & Scott (85), who reported that the proportion of complete dominance relationships was higher in basenjis and wirehaired terriers than in beagles and cocker spaniels. In the latter breeds, dominance tests frequently gave inconclusive results. The breed differences were largely due to the strong dominance of males over females in the basenjis and terriers.

The stability of social groups in inbred mouse strains was considered by Calhoun (19) to reflect the physiological homeostasis of individuals who make up the population. In his experiments, artificial communities of DBA/2 mice were much less stable than those of C57BL/10 mice. Calhoun's hypothesis is that physiological instability in the DBA results in emotional arousal, failure to make the fine discriminations needed for social adjust-

ment, and the eventual breakdown of social organization. The case for DBA instability rested largely upon their high susceptibility to audiogenic seizures.

Intelligence and learning.—Thompson (118), in summarizing three-quarters of a century's work on the inheritance of intelligence, stated that, as a result of it all, perhaps two conclusions were justifiable: (a) intelligence is heritable to a degree and (b) depriving an organism of stimulation during early life has permanent deleterious effects on its development. Five years of additional work have not changed the situation greatly, but there is perhaps an indication in recent research that the interaction between genotype and the nature of early experience as well as other factors affecting intelligence has not previously been fully appreciated.

The bright and dull rat strains developed at McGill (118) have been used in a number of studies which attempt to characterize their differences in performance in a more precise form. On a test of exploratory activity in a Y-maze, bright rats showed a faster decline of activity within trials and explored in a more orderly manner (120). They also seemed to discriminate better between two different mazes and explored less in one which had been previously investigated. The author explained the effects in terms of differential susceptibility to retroactive inhibition. These strains, transferred to the University of Manitoba, have also been used to retest the controversial glutamic-acid-effect on the development of intelligence. Large doses of glutamic acid failed to improve the performance of bright rats on a Hebb-Williams maze, but produced significant improvement in dull rats (61). The effect is considered by these authors to be relatively permanent (62) on the basis of a finding that treated rats were still superior on retests 30 and 60 days after drug administration. However, the difference between the groups fell progressively, and, in terms of improvement from trial to trial, control animals were superior on the retests. The experiment should be repeated with additional control groups. In a later experiment (60) glutamic acid enhancement was not obtained for reasons which are still obscure. Perhaps the most interesting of this group of papers is a study of the effects of enriched and restricted early environment on the performance of these strains in the Hebb-Williams maze (27). In an enriched environment, bright and dull rats both made few errors; in a restricted environment, both made many errors. In neither case were the strain differences significant. Under normal laboratory rearing conditions, the expected gross difference in performance was obtained. The results suggest a sort of threshold effect. Dull rats do not have a lower potentiality, but they do require more stimulation to attain a high level of performance. Both bright and dull rats appear to have the same ceiling.

Somewhat similar in concept to the Cooper & Zubek experiment was a study of the effect of the conflict situation on learning ability in two strains of inbred mice (69). Two strains of mice were compared in avoidance performance in a shuttle box after half of each genetic group had been put under severe stress by shocking them whenever they drank. The control C57BL

subjects performed significantly better than BALB/cs, but the two strains behaved similarly after stress. Here, too, there is evidence that the same treatment has unlike effects on the learning of different genotypes. An abstract by McClearn (75) describes strain differences between inbred mouse strains in performance on an elevated Lashley III maze. Presumably this will be used as a basis for additional genetic analysis. Differences in learning ability of dog breeds have been described by Fuller & Scott (45). It appears that heredity affects performance on almost any test which an experimenter may select.

BEHAVIOR GENETICS OF MAN

Laterality.—The phenomena of handedness and eye dominance have long been favorite subjects for behavioral genetics. Handedness itself, as a trait, may not be of major social importance, although various ills have been attributed to forcefully changing "innate handedness"; however, study of the trait does provide a testing ground for ideas on the nature-nurture interaction. An extensive analysis of three older studies on the familial occurrence of left-handedness was carried out by Trankell (121). He applied the classical methods of population genetics to the problem, with a correction for the fact that there is a strong environmental pressure against the manifestation of left-handedness. Using this model, he showed that the older studies of Ramaley, Chamberlin, and Rife were in substantial agreement with a monogenic recessive determination of left-handedness. Estimates for the frequency of the gene in all three populations were just over 0.40. Trankell's method, the calculus of penetrance, is presented as a general technique for population genetic analysis of behavioral traits.

Two other papers dealing with the handedness problem include new data. Merrell (79) compared eye and hand dominance in his subjects and their families. Although heritability of both types of laterality was shown, the association between the two was not significant, and Merrell concluded that they must have developed independently. Merrell supports Rife's theory that left-handedness is a monogenic recessive and that all homozygous (rr) individuals are left-handed. Heterozygotes (Rr) are developmentally labile and are equally likely to go in either direction. The model is quite different from Trankell's, but we have no critical test between them. Falek (36) was more concerned with the details of the nature-nurture interaction in the development of handedness than in genetic models. His study was based on a sample of parental matings of the types right-handed \times right-handed, right-handed \times left-handed, and left-handed \times left-handed. The interesting feature of Falek's results was that the heritability of left-handedness was a function of the sex of the left-handed parent and the occupational status of the parent. Left-handed fathers who were skilled laborers have fewer left-handed children than might be expected. From the results of personal interviews, Falek attributed this to the fact that these parents find left-handedness a disadvantage in their daily work and strongly train their children against it. The

fact that some children in the sample persisted in left-handedness despite strong contravening measures was taken to indicate the importance of genetic factors, as was the higher proportion of left-handedness in the relatives of the left-handed index cases.

Two studies on the development of handedness were not, strictly speaking, concerned with heredity, but do point up problems involved in studying heritability of a trait whose overt expression becomes more pronounced with practice. Cole (26) studied paw preference in cats and rejected the hypothesis that laterality preference is the result of feeding habits. He was able to reverse handedness by small lesions in the contralateral motor cortex and suggested that an anatomical asymmetry might lie at the base of lateral preferences. Warren (127) further investigated the development of paw preferences in cats and monkeys, finding that the degree of laterality increased with practice and was more pronounced on tasks requiring finer coordination. He concluded that learning is more important in the higher mammalian orders such as primates, and criticized Cole, not so much for his being wrong as for his naïveté. However, Warren's own explanation overlooked the differences in developmental rates between the various species of mammals. By the time a human infant is born, it is already older chronologically than a cat which may have developed a clear-cut handedness. The longer ambilaterality of the primates may reflect nothing more than a slower biological development. Warren characterizes the nature-nurture issue as a "pseudoproblem," which is fair enough insofar as a single individual is concerned. One's handedness cannot be divided up into inherited and acquired parts. But the differences between individuals in handedness may result solely from one class of factor or the other. This point still needs attention.

Personality.—The popularity of the Pogo cartoons indicates a public acceptance of a relationship between animal traits and human personality. In scientific psychology the areas seem rather far apart. Animal temperament is defined for behavior genetics according to activity or aggression scores; human personality is defined in terms of introversion-extraversion and cyclothymia. Perhaps their chief common element is the fact that both are heritable to a degree.

The classical method of comparing monozygotic and dizygotic twins continues to be used in personality studies. Monozygotic twins reared apart appear to be commoner than previously believed (63). Shields (107) found that the risk of psychiatric disorder in twins is approximately the same as in the general population. He found strongest evidence for genetic effects in psychosomatic disorders, but claimed that genetic factors cannot be ruled out for neurotic symptoms. In a later study (108) he reported on a fairly large sample of monozygotic twin pairs reared apart. These were compared with a control sample of twins reared together. Correlations between members of pairs on an extraversion-introversion test were .60 and on a neuroticism test .52. Shields concluded from these tests and from clinical judgments of personality that twins reared apart are about as much alike as twins reared to-

gether. "Our material shows that uniovular twins can be alike without the operation of subtle intrafamilial or intertwin relationships. If nothing else, it goes some way toward vindicating some of the pre-suppositions of twin research." In another comprehensive twin study, Eysenck (35) compared the two types of twins with respect to similarity on intelligence factors, an extraversion-introversion factor, and an autonomic factor. Though intercorrelations between the three factors were nonsignificant, monozygotic twins were significantly more alike on all three. Together with earlier research from the Maudsley group, these papers represent an attempt to describe personality in terms of a group of independent heritable factors. The factor analytic approach to trait definition was also used in a series of studies by Cattell and co-workers (21, 22) at the University of Illinois. The personality factors employed for phenotypic description are derived from personality tests designed by Cattell himself. In contrast to the standard twin method, the Illinois group works with personality correlations within families of different types, for example, monozygotic twin pairs, dizygotic twin pairs, unrelated children reared together, related children reared apart, and the like. The variance equations contain terms for the between- and within-family hereditary factors, the between- and within-family environmental factors, and their intercorrelations. The equations are not uniquely solvable, but solutions may be developed on the basis of certain psychological assumptions and the internal consistency of the data. Applying these methods, it has been found that certain factors have particularly high genetic determination in a sample of middle western male children 9 to 14 years of age. These factors are general intelligence, comention, and cyclothymia. Particularly low heritability was found for an assertiveness factor and immediate overresponsiveness. As might have been predicted from Thompson's (119) theoretical analysis, factors, in general, showed a combination of environmental and genetic determination. It is highly doubtful that the method can lead directly to personality factors which are completely determined by heredity and, hence, represent basic biological nature. Nevertheless, the method is powerful and might well be used on a larger scale.

In contrast to the highly structured approach to personality through factor analysis is the more naturalistic type of appraisal which was started over 20 years ago by Gottschaldt (48). Twins from many German cities were brought together in a summer camp, and longitudinal studies have been conducted on many of them. The "endothymic" traits of personality are considered to have remained stable and are strongly heritable. Intellectual interests have been modified by life experiences.

Intelligence and learning.—Turning to the studies on the genetics of intelligence in man, we find that conflicting views are still expressed at the end of three-quarters of a century's investigation. Twin investigations continue to show that monozygotic twins are much more alike than dizygotic pairs on both general intelligence and on tests purporting to measure primary mental abilities (12). Vandenberg (125) has published preliminary results of the

University of Michigan twin study which employed many psychological and physiological tests. In general, the computed heritability of intelligence was less than that of body measurements, but a little greater than that of personality tests or of many physiological and biochemical measures. This may be explained by the fact that intelligence is a more stable characteristic of an organism than is urinary excretion or specific metabolites. Burt (18) has presented a rather thorough summary of his extensive researches on the inheritance of intelligence in the London school system. With Howard (18a), he has proposed a multifactorial theory for the inheritance of intelligence within the normal range. Single Mendelian factors seem to be involved primarily in the determination of mental defect. Burt believes that the hypothesis of intelligence as a general ability is more valid than the assumption of the existence of discrete independent mental factors. His balance sheet for the partition of the variance of intelligence scores gives greater weight to genetic factors than does any other with which this investigator is acquainted. The computations are based upon test scores which were adjusted by consideration of teachers' records on individual students. In this allocation, the fixable genetic component is stated to be 47.92 per cent; nonfixable genetic, 21.73 per cent; assortive mating, 17.1 per cent; systematic environmental, 1.43 per cent; random environmental, 5.77 per cent; and unreliability, 5.24 per cent. These results, as Burt states, apply only to the specific population studied. They stand in marked contrast to views such as those expressed by Sarason & Gladwin (101), who state, "Although at the present time practically all responsible workers in the field recognize that conclusive proof of the heritability of mental ability is still lacking, where no organic or metabolic pathology is involved, the assumption that subnormality has a genetic basis continues to crop up in scientific studies." Unfortunately, much of the evidence against which Sarason & Gladwin train their guns is based on intelligence-test differences between racial groups. These are no more satisfying to geneticists than to psychologists. This same paper states that most psychologists "recoil in alarm over the implication that the IQ be taken as a measure of inherent as against learned mental capacity, yet this presumption must be made if the IQ is to be considered genotypic." This statement betrays confusion over a fundamental distinction of genetics, the distinction between genotype and phenotype. Intelligence has never been considered genotypic, and an extremely complex network of events lies between an IQ score and a set of genes. The striking fact is that this complex network is orderly, and predictable relationships can be found between genes and complex phenotypes such as intelligence.

It is, of course, true that intelligence does not spring full-formed from a set of genes but is stimulated by many subtle factors. One of these, family size, has been studied over a number of years by Nisbet (84). There was little change from 1949 to 1956 in the significant negative correlation between number of siblings and intelligence test scores. Nisbet's hypothesis is that children in larger families receive inadequate verbal stimulation and hence

do less well on the standard intelligence tests. Allen (2, 3) has provided effective summaries of the genetic approach to problems of mental disorder, particularly mental deficiency. He deals with one rather subtle argument that the persistence of mental disease in the face of negative natural selection proves its nongenetic etiology. This argument holds that the lowered fertility of the defective individual should, over the course of generations, eliminate the responsible gene. The weakness of the criticism lies in the fact that selection acts upon phenotypes and not genotypes. The responsible gene may not be exposed to natural selection, for it may appear late in life after the reproductive age, or be rarely expressed except in industrial societies. Since industrial society is a new phenomenon, this means that selection has had very few generations to operate. Allen's most interesting suggestion is that many genes which produce deleterious effects under certain circumstances may be paying their way by some other action which is positively selected. This view is possibly borne out by the recent report that psychoses are more common in persons with blood type "O" than in the general population (17). Although many forms of feeble-mindedness are associated with specific Mendelian units, it is still true that common high-grade familial mental deficiency is best accounted for in genetic terms as a cumulative effect of multiple genes. A particular genotype should not be considered, however, to set a ceiling on intellectual capacity. For each person, heredity fixes an IQ corresponding to every possible environment to which he might be exposed. As medical and educational techniques improve, the development of the familial mental defective may well be changed for the better. Like the Cooper & Zubek dull rats, the moron may simply be an individual who must have a highly stimulating environment to develop average intelligence.

Behavior deviations.—Psychiatric genetics will not be discussed here in detail, but a few papers will be cited to illustrate some of the current activities. The extensive genetic and clinical study of enuresis reported by Hallgren (51) is a model for family investigations. The investigation was based upon cases referred to pediatric clinics and all were followed up by the author. This study includes detailed investigations of the clinical history of the index cases, and the role of environmental factors in etiology is thoroughly discussed. Following this analysis, Hallgren concludes that there is probably a "nuclear" group of enuretics whose condition is attributable primarily to genetic factors. The data do not permit distinguishing between the hypothesis that susceptibility depends on a dominant of incomplete penetrance and one based upon a polygenic system which determines a threshold of susceptibility to environmental factors.

The heritability of psychoses, particularly schizophrenia, was reviewed by Kallman (63a). The case for genetic factors is strong, but agreement has not been reached on the nature of the genetic system. Slater (110) has made computations to test Bööks' hypothesis that schizophrenia has a monogenic basis, and that it is manifested in all homozygotes and in one-fifth of heterozygotes. The expectation of schizophrenia, s , is then given by

the equation $s = 2mp(1-p) + p^2$, where m is the manifestation rate in the heterozygotes and p is the frequency of the essential gene. For each and every value of p and m , it is possible to calculate theoretical expectations for the occurrence of schizophrenia in various classes of relatives of affected individuals. Slater has carried out these computations and matched the results against the empirical data of a number of investigators from different countries of Western Europe. He believes that the statistical evidence agrees with the theory, and that the best values in the series of samples are $m = 0.26$; $p = 0.015$. Mitsuda (83) has utilized genetic techniques to analyze the relationships between schizophrenia, manic-depression, and epilepsy. The "atypical" schizophrenias seem to be related to other psychoses, while "typical" schizophrenia stands by itself.

A general discussion of the application of genetic expectancies to the study of human behavior disorders has been presented by Pearson & Kley (86). These writers advocate the use of empirical family morbidities for empirical prognosis regardless of their genetic or environmental causation. They also have the opinion that extremely low and high individuals on any psychological scale may represent genetic deviates of unique genes, not merely the low or high accumulation of polygenes. Even genius might, in their opinion, be a single factor, as has been proved to be the case for many types of feeble-mindedness. This view, of course, contrasts with the more conventional belief that the high deviates in intelligence can be accounted for completely within the normal curve. From the practical point of view, Pearson & Kley advocate more use of special populations for the psychological study of development of behavior disorders. Research on a sample of children with schizophrenic relatives, for example, would yield more information per unit of effort on the etiological factors in this disease than the study of a random sample from the general population.

PHYSIOLOGICAL NATURE OF GENETIC EFFECTS

It is commonly agreed that genes act primarily upon metabolic processes and that their most immediate effects are to be found in the variations of enzyme systems or in the production of specific antigenic substances. It is the enzymes which have attracted the attention of some behavior geneticists. Ginsburg (46) reported on the effects of a large number of metabolically active compounds upon susceptibility of various mouse strains to audiogenic seizures. Substances which increased the occurrence of seizures in one strain did not necessarily do so in another. This was interpreted as an indication that different metabolic deficiencies may be responsible for similar nervous instability of the two strains. A given behavioral phenotype may arise from a variety of genetic causes. Thus the C57BL/6 and C57BL/10 mice are behaviorally indistinguishable with respect to audiogenic seizure susceptibility, but breeding experiments prove that the genetic basis is not the same in the two strains. The experiments of Abood & Gerard (1) showed that mice, dur-

ing their age-period of susceptibility, were deficient in brain enzymes. At least some cases of strain differences in seizure resistance could be accounted for by differences in amount of the enzyme, ATPase, and in the rates of active phosphorylation. Interestingly, the more susceptible strains, which emit most energy when stimulated, are those showing a deficiency of energy releasing systems in the brain.

Ginsburg (47) in a later theoretical and summarizing paper proposed that genetically produced enzymatic variations be used as natural units in behavior genetics. He suggests that the effects of such disorders as phenylketonuria, tyrosinosis, and alcaptonuria be studied in a series of related organisms. The behaviors affected would, in his opinion, be homologous since they would be related to the same biochemical structures. The use of genetic strains to study the effects of metabolic variation upon behavior is certainly one of the important contributions of behavior genetics. One may question, however, Ginsburg's statement that a series of genotypes, each leading in its own way to a behavioral phenotype that represents a deviation from the normal, provides a natural dissection of the nervous system. Phenylketonuria may be genetically and biochemically simple, but it does not disturb a single neurological or psychological unit. Instead, it is associated with a syndrome, a group of diverse behavioral effects which are mutually affected by a disorganization of metabolism. Despite the importance of genetic psychochemistry, it should not become a sort of biochemical phenology. Biochemistry can assist in locating carriers of recessive genes which are responsible for disorders such as phenylketonuria (71), but the natural units of behavior must be defined at a behavioral level, not in terms of genetics, chemistry, or neurology.

Another series of experiments relating behavior genetics to enzymes has been carried out at the University of California (72, 73, 95, 97). These investigators, employing descendants of Tryon's maze-bright and maze-dull rats, have reported a correlation between cholinesterase concentration in the brain and adaptive behavior as tested in the Krech hypothesis apparatus. The early papers stated that high brain cholinesterase was related to visual preference in the Krech apparatus, but later it was found that the strains differed in a more complex manner which was brought out when the visual or spatial stimuli were made progressively more and more reliable cues to the maze pattern. The concentration of brain cholinesterase obviously differs between strains and changes characteristically for each during the life cycle. Experiments by Roderick (93) showed that it was possible by selection to produce rat strains with either high or low brain cholinesterase, but the animals' behavior in hypothesis apparatus did not agree with the earlier findings. Animals of the low cholinesterase strain proved to be more spatial and more adaptive. Chow & John (24) found that spatial and visual preferences of the two rat strains were not modified by intracerebral injection of anticholinesterase drugs, even with dosages which produced gross disturbances such

as ataxia and convulsions. On this basis, the authors criticize the hypothesis that adjustive behavior is correlated with brain cholinesterase, but their criticism has been challenged (96). Whether or not the cholinesterase hypothesis is confirmed by other workers, it is obvious that the relationship between the brain enzyme and complex adaptive responses is indirect and may vary from one strain to another. Cholinesterase variations can be demonstrated in natural populations as well as in laboratory strains and the possibility exists that these have adaptive value (33). Obviously, much more research is needed in this area.

A few papers have dealt with hormone activity and neurological factors as pathways through which genetic variation is reflected in behavioral differences. Relatively aggressive and nonaggressive strains of mice castrated and given equal doses of testosterone, androsterone, and dehydroisoandrosterone continued to behave in fighting tests in a manner compatible with their status as intact animals (11). These results greatly resemble those of the Kansas group on the hormonal control of sexual behavior. A somatic difference in response to hormones, rather than a difference in hormone production, seems to be the source of the strain difference in behavior. Such results may be particularly characteristic of the steroid hormones. Thyroid activity in mice has been shown to be under genetic control and the generalized activity of the strains seems to be positively correlated with the rate of thyroid metabolism (4, 23). It would be interesting to test for the existence of a somatic response factor to thyroid hormones, using activity as an index.

Only one paper was found relating neurological findings to strain differences in emotionality. King (65) placed electrolytic lesions in the septum of highly reactive Lashley hooded rats and in more passive Wistar albino rats. Both strains became more aggressive, but the relative position of the strains on a rating scale was not abolished by the operation. Again, the evidence favors a pervasive somatic factor which is not localized in a particular brain area nor referable to a specific hormone.

EVOLUTION OF BEHAVIOR

Three papers, presented in a symposium on mammalian genetics, have utilized the process of domestication as a model of evolution (88, 102, 112). This, it will be remembered, was a fundamental part of Darwin's original evolutionary arguments. Richter believes that the behavioral changes in rats seen under domestication are largely a manifestation of endocrine differences. Selection for docility has brought about a reduction in the importance of the adrenal glands and a corresponding increase in the significance of the gonads and pituitary. Such changes are a concomitant of selection for fertility and successful rearing of offspring under laboratory conditions. Scott has compared the behavior of dogs with wolves and considers that no new patterns have appeared under domestication. Rather, the frequency and inten-

sity of some components have been altered. Snyder's paper is concerned with the effects of selection in man upon changes in intelligence. He does not believe there is any real danger of a drop in intelligence because of differential fertility associated with scores on intelligence tests. Whether natural selection continues to operate in modern man has been considered by Dobzhansky & Allen (31). Essentially their answer is "Yes," but the genotypes which possess highest Darwinian fitness in the environments created by man are not the ones most favored by selection in the past. In the Darwinian sense, fitness is measured by the survival of one's genes, which is equivalent to the number of one's offspring. Dobzhansky & Allen suggest, however, that the cultural bridge of human society is such that the number of one's grandchildren may be a more adequate measure of fitness. Like Snyder, they hold a reasonably optimistic view of man's genetic future, but they do make a plea for continuous attention to the human gene pool. Man must be prepared to take over controls for conservation of genes if this is necessary to correct the deficiencies of natural selection. Insofar as the genetic mechanisms of behavioral evolution are concerned, mankind offers a fertile field for speculation, but the changes from the Pleistocene to the Atomic Age are probably explained better by cultural historians than by geneticists. The evolutionary process can, however, lead to behavioral divergence in species who have only the most rudimentary, if any, aspects of culture. Physiological variation among geographical or ecological races of a single species is well documented (87). In many instances, the physiological differences are manifested also in behavior. In the previously cited Roe & Simpson volume (94), Mayr, Spieth & Pitendrih concern themselves with such problems as the conflict between selection for a fixed mode of response which is optimum under average conditions, and a plastic response system which adapts itself to the particular conditions to which it is exposed. Both systems are equally under genetic control and both are highly successful in appropriate circumstances.

The plastic adaptive response system is one which effectively carries out the function known to psychologists as learning. The evolution of this capacity has been discussed by Harlow (51a), who has made important contributions in this area. He states that "the study of animals under laboratory conditions reveals many learning capabilities whose existence is hard to understand in terms of survival value." In contrast with such writers as Etkin (34) and Dobzhansky (30), Harlow minimizes the basic psychological gap between phylogenetic levels and, particularly, between other primates and man. If one accepts his view that organisms are more intelligent than is demanded by the ordinary conditions of life, one is forced to de-emphasize the importance of natural selection. A point which Harlow does not consider, however, is that the nervous system may be more efficient when working under less than full load. The unrealized capacities may simply be inevitable by-products of natural selection operating to produce a brain which will be highly efficient at ordinary operating levels. In engineering terms, natural

selection may operate to produce a margin of safety in the design of the brain.

King (67) has tried to relate behavioral differences between subspecies of *Peromyscus maniculatus* to rates of biological development. Specifically, he attempts to show a positive correlation of slow maturation with tameness. It would be desirable to extend these observations to a larger sample of subspecies to determine their generality.

In summary, students of behavior and evolution have given serious thought to the pathways between genes and behavior and the ways in which selection might lead to a change in gene frequencies. At this level, population genetics and physiological genetics both join hands with psychology. There is perhaps a place for additional selection experiments in the laboratory in which the objective will not be so much the production of divergent strains to be used as experimental subjects, but rather an understanding of the evolutionary process. Fossil behavior is not available to the psychologist, so that it is unlikely that he can reconstruct the past as accurately as the paleontologist. Laboratory science can make a contribution to evolutionary theory, however, through the testing of simple models involving behaviors of known heritability.

SUMMARY

Behavior genetics is currently undergoing reactivation, though certain types of studies, notably selection experiments with mammals, are not sharing in this upswing. Strain comparisons and twin studies (which are equivalent to strain comparisons) are becoming oriented toward considering genotype as an independent variable and behavior as a dependent variable. This point of view is replacing the effort to identify the genes for activity, wildness, or hoarding. This type of investigation appears to pay off only with insects and fishes. In accordance with the available stocks and with the genetic skills of the investigator, it is possible to manipulate single genes, chromosomes, or whole genotypes. For the most part, psychologists have dealt with genotypes as a whole. With *Drosophila* and even to an extent with mice, it is now possible to observe the effects of smaller genetic units.

Another active area in behavior genetics is the manipulation of chemical and physiological characteristics of the organism through selection and inbreeding. Such material has great potential value for physiological psychology, and it is not being exploited adequately. Eventually all behavior genetics may reduce to the determination of the heritability of organic traits, and the study of the effects of such characters upon behavior. The prospect appears remote at this time.

It is neither necessary nor desirable that there be a mass conversion of psychologists from the investigation of environmental variables to the study of genetic variables. The number of studies, however, which have shown significant interaction between genotype and treatment indicates that psy-

chologists have often generalized too broadly from the Wistar albino rat. Early handling, rearing in isolation, glutamic acid, testosterone, and septal lesions, for example, can change behavior but their effects are not unrelated to the genetic substrate of the organism to which they are applied. The moral is obvious: experimenters must restrict their generalizations or test them on a wider variety of organisms. On the one hand, the experimenter can control heredity and carry out his tests on a wide variety of genotypes. On the other hand, he may work with genetically uncontrolled and heterogeneous material to insure that some of his subjects will be susceptible to the agent being tested. In the latter case he will be unable to separate interaction and experimental error, but he will be less likely to confuse the peculiarities of a single genotype with a general law. Adequate consideration of genetic factors may help to eliminate some current disagreements in the literature.

LITERATURE CITED

1. Abood, L. G., and Gerard, R. W. Phosphorylation defect in the brains of mice susceptible to audiogenic seizure. In *Biochemistry of the Developing Nervous System*, 467-72 (Waelsch, H., Ed., Academic Press, New York, N. Y., 537 pp., 1955)
2. Allen, G. Genetic aspects of mental disorder. In *Nature and Transmission of the Genetic and Cultural Characteristics of Human Populations*, 112-21 (Milbank Fund, New York, N. Y., 143 pp., 1957)
3. Allen, G. Patterns of discovery in the genetics of mental deficiency. *Am. J. Mental Deficiency*, **62**, 840-49 (1958)
4. Amin, A., Chai, C. K., and Reineke, E. P. Differences in thyroid activity of several strains of mice and F₁ hybrids. *Am. J. Physiol.*, **191**, 34-36 (1957)
5. Anastasi, A. *Differential Psychology*, 3rd ed. (The Macmillan Co., New York, N. Y., 894 pp., 1958)
6. Anastasi, A. Heredity, environment, and the question "how?" *Psychol. Rev.*, **65**, 197-208 (1958)
7. Anliker, J., and Mayer, J. An operant conditioning technique for studying feeding-fasting patterns in normal and obese mice. *J. Appl. Physiol.*, **8**, 667-70 (1956)
8. Bastock, M. A gene mutation which changes a behavior pattern. *Evolution*, **10**, 421-39 (1956)
9. Bastock, M., and Manning, A. The courtship of *Drosophila melanogaster*. *Behaviour*, **8**, 85-111 (1955)
10. Bauer, F. J. Genetic and experimental factors affecting social relations in male mice. *J. Comp. Physiol. Psychol.*, **49**, 359-64 (1956)
11. Bevan, W., Levy, G. W., Whitehouse, J. M., and Bevan, J. M. Spontaneous aggressiveness in two strains of mice castrated and treated with one of three androgens. *Physiol. Zool.*, **30**, 341-49 (1957)
12. Blewett, D. B. An experimental study of the inheritance of intelligence. *J. Mental Sci.*, **100**, 922-33 (1954)
13. Broadhurst, P. L. Determinants of emotionality in the rat. I. Situational factors. *Brit. J. Psychol.*, **48**, 1-12 (1957)
14. Broadhurst, P. L. Determinants of emotionality in the rat. II. Antecedent factors. *Brit. J. Psychol.*, **49**, 12-20 (1957)
15. Broadhurst, P. L. Determinants of emotionality in the rat. III. Strain differences. *J. Comp. Physiol. Psychol.*, **51**, 55-59 (1958)
16. Broadhurst, P. L. Studies in psychogenetics: the quantitative inheritance of behaviour in rats investigated by selective and cross-breeding. *Bull. Brit. Psychol. Soc.*, **34**, 2A (1958)
17. Buckwalter, J. A., Turner, J. H., Gamber, H. H., Raterman, L., Soper, R. T., and Knowler, L. A. Psychoses, intracranial neoplasms and genetics. *A.M.A. Arch. Neurol. Psychiat.*, **81**, 480-85 (1959)
18. Burt, C. The inheritance of mental ability. *Am. Psychologist*, **13**, 1-15 (1958)
- 18a. Burt, C., and Howard, M. The multifactorial theory of inheritance and its application to intelligence. *Brit. J. Stat. Psychol.*, **9**, 95-131 (1956)
19. Calhoun, J. B. A comparative study of the social behavior of two inbred strains of house mice. *Ecol. Monographs*, **26**, 81-103 (1956)

20. Carr, R. M., and Williams, C. D. Exploratory behavior of three strains of rats. *J. Comp. Physiol. Psychol.*, **50**, 621-23 (1957)
21. Cattell, R. B., Blewett, D. B., and Beloff, J. R. The inheritance of personality. *Am. J. Human Genet.*, **7**, 122-46 (1955)
22. Cattell, R. B., Stice, G. F., and Kristy, N. F. A first approximation to nature-nurture ratios for eleven primary personality factors in objective tests. *J. Abnormal Soc. Psychol.*, **54**, 143-59 (1957)
23. Chai, C. K., Amin, A., and Reineke, E. P. Thyroidal iodine metabolism in inbred and F₁ hybrid mice. *Am. J. Physiol.*, **188**, 499-502 (1957)
24. Chow, K. L., and John, E. R. Effects of intracerebral injections of anticholinesterase drugs on behavior in rats. *Science*, **128**, 781-82 (1958)
25. Clark, E., Aronson, L. R., and Gordon, M. Mating behavior patterns in two sympatric species of Xiphophorus fishes: their inheritance and significance in sexual isolation. *Bull. Am. Museum Nat. Hist.*, **103**, 135-226 (1954)
26. Cole, J. Paw preference in cats related to hand preference in animals and man. *J. Comp. Physiol. Psychol.*, **48**, 137-40 (1955)
27. Cooper, R. M., and Zubek, J. P. Effects of enriched and restricted early environments on the learning ability of bright and dull rats. *Can. J. Psychol.*, **12**, 159-64 (1958)
28. Curtis, R. L. Quantitative measurement of hereditary circling behavior in the BUD and BUE mouse strains. *Physiol. Zool.*, **29**, 299-308 (1956)
29. Dember, W. N., and Kristofferson, A. B. The relation between free-choice alcohol consumption and susceptibility to audiogenic seizures. *Quart. J. Studies Alc.*, **16**, 86-95 (1955).
30. Dobzhansky, T. The biological concept of heredity as applied to man. In *The Nature and Transmission of the Genetic and Cultural Characteristics of Human Populations*, 11-19 (Milbank Memorial Fund, New York, N. Y., 143 pp., 1957)
31. Dobzhansky, T., and Allen, G. Does natural selection continue to operate in modern mankind? *Am. Anthropologist*, **58**, 591-604 (1956)
32. Dürnwächter, G. Untersuchungen über Phototaxis und Geotaxis einiger *Drosophila* Mutanten nach aufzucht in verschiedenen Lichtbedingungen. *Z. Tierpsychol.*, **14**, 1-28 (1957)
33. Eleftheriou, B. E. A comparative study of the cholinesterase activity in the brains of two subspecies of deermice, *Peromyscus maniculatus*. (Master's thesis, Univ. of Massachusetts, Amherst, Mass., 1959)
34. Etkin, W. Social behavior and the evolution of man's mental faculties. *Am. Naturalist*, **88**, 129-42 (1954)
35. Eysenck, H. J. The inheritance of extraversion-intraversion. *Acta Psychol.*, **12**, 95-110 (1956)
36. Falek, A. Handedness, a family study. *Am. J. Human Genet.*, **11**, 52-62 (1959)
37. *Proc., Intern. Congr. Psychol., 15th Meeting* (Brussels, Belgium, 1957); *Acta Psychol.*, **15**, 658 pp. (1959)
38. *Proc. Intern. Congr. Human Genet., 1st Meeting* (Copenhagen, Denmark, 1956; Kemp, T., Ed., S. Karger, Basel, Switzerland, 970 pp., 1957); *Acta Genet. et Statist. Med.*, **6**, 157-613 (1957); **7**, 1-512 (1957)

39. Fredericson, E., and Birnbaum, E. A. Competitive fighting between mice with different hereditary backgrounds. *J. Genet. Psychol.*, **85**, 271-80 (1954)
40. Fredericson, E., Story, A. W., Gurney, N., and Butterworth, K. The relationship between heredity, sex, and aggression in two inbred mouse strains. *J. Genet. Psychol.*, **87**, 121-30 (1955)
41. Freedman, D. G. Constitutional and environmental interactions in rearing of four breeds of dogs. *Science*, **127**, 585-86 (1958)
42. Freedman, D. The effects of "indulgent" and "disciplinary" rearing in four breeds of dogs. *Acta Psychol.*, **15**, 479-80 (1959)
43. Frings, H., Frings, M., and Hamilton, M. Experiments with albino mice from stocks selected for predictable susceptibilities to audiogenic seizures. *Behaviour*, **9**, 44-52 (1956)
44. Fuller, J. L., and Jacoby, G. A. Central and sensory control of food intake in genetically obese mice. *Am. J. Physiol.*, **183**, 279-83 (1955)
45. Fuller, J. L., and Scott, J. P. Heredity and learning ability in infrahuman mammals. *Eugenics Quart.*, **1**, 28-43 (1945)
46. Ginsburg, B. E. Genetics and the physiology of the nervous system. *Research Pubs., Assoc. Research Nervous Mental Disease*, **33**, 39-56 (1954)
47. Ginsburg, B. Genetics as a tool in the study of behavior. *Perspectives Biol. Med.*, **1**, 397-424 (1958)
48. Gottschaldt, K. Zwillungspsychologische Forschungen zur Frage der Phäno-genetik der Person. *Acta Psychol.*, **15**, 381-83 (1959)
49. Goy, R. W., and Young, W. C. Strain differences in the behavioral responses of female guinea pigs to alpha-estradiol benzoate and progesterone. *Behaviour*, **10**, 340-54 (1957)
50. Goy, R. W., and Young, W. C. Somatic basis of sexual behavior patterns in guinea pigs. *Psychosomatic Med.*, **19**, 144-51 (1957)
51. Hallgren, B. Enuresis, a clinical and genetic study. *Acta Psychiat. Neurol. Scand.*, **32**, Suppl. 114, 1-159 (1957)
- 51a. Harlow, H. The evolution of learning. In *Behavior and Evolution*, Chap. 13, 269-90 (Roe, A., and Simpson, G., Eds., Yale University Press, New Haven, Conn., 557 pp., 1958)
52. Haskins, C. P., and Haskins, E. F. Note on the inheritance of behavior patterns for food selection and cocoon spinning in F₁ hybrids of *Callosamia promethea* × *C. angulifera*. *Behaviour*, **13**, 89-95 (1958)
53. Hinde, R. A. The behaviour of certain cardueline F₁ interspecies hybrids. *Behaviour*, **9**, 202-13 (1956)
54. Hirsch, J. Recent developments in behavior genetics and differential psychology. *Diseases of Nervous System. Monograph Suppl.*, **19**, 17-24 (1958)
55. Hirsch, J., and Boudreau, J. C. The heritability of phototaxis in a population of *Drosophila melanogaster*. *J. Comp. Physiol. Psychol.*, **51**, 647-51 (1958)
56. Hirsch, J., and Tryon, R. C. Mass screening and reliable individual measurement in the experimental behavior genetics of lower organisms. *Psychol. Bull.*, **53**, 402-10 (1956)
57. Hooker, D., and Hare, C. C., Eds. *Genetics and the Inheritance of Integrated Neurological and Psychiatric Patterns* (The Williams & Wilkins Co., Baltimore, Md., 425 pp., 1954); *Research Pubs., Assoc. Research Nervous Mental Disease*, **33** (1954)

58. von Hörmann, S. Über den Erbgang von Verhaltensmerkmalen bei Grillen bastarden. *Naturwissenschaften*, **42**, 470-71 (1955); *Z. Tierpsychol.*, **14**, 137-83 (1957)
60. Hughes, K. R., Cooper, R. M., and Zubek, J. P. Effect of glutamic acid on the learning ability of bright and dull rats. III. Effect of varying dosages. *Can. J. Psychol.*, **11**, 253-55 (1957)
61. Hughes, K. R., and Zubek, J. P. Effect of glutamic acid on the learning ability of bright and dull rats. I. Administration during infancy. *Can. J. Psychol.*, **10**, 132-38 (1956)
62. Hughes, K. R., and Zubek, J. P. Effects of glutamic acid on the learning ability of bright and dull rats. II. Duration of the effect. *Can. J. Psychol.*, **11**, 182-84 (1957)
63. Juel-Nielsen, N., and Mogensén, A. Uniovular twins brought up apart: preliminary report of a psychiatric-psychological study. *Acta Genet. Stat. Med.*, **7**, 430-33 (1957)
- 63a. Kallman, F. J. The genetics of psychotic behavior patterns. *Research Publs., Assoc. Research Nervous Mental Disease*, **33**, 357-66 (1954)
64. Kallman, F. J., and Baroff, G. S. Abnormalities of behavior (in the light of psychogenetic studies). *Ann. Rev. Psychol.*, **6**, 297-326 (1955)
65. King, F. A. Relationship of the "septal syndrome" to genetic differences in emotionality in the rat. *Psychol. Repts.*, **5**, 11-18 (1959)
66. King, J. A. Closed social groups among domestic dogs. *Proc. Am. Phil. Soc.*, **98**, 327-36 (1954)
67. King, J. A. Maternal behavior and behavioral development in two subspecies of *Peromyscus maniculatus*. *J. Mammalogy*, **39**, 177-90 (1958)
68. King, J. A., and Eleftheriou, B. E. Effects of early handling upon adult behavior in two subspecies of deermice, *Peromyscus maniculatus*. *J. Comp. Physiol. Psychol.*, **52**, 82-88 (1959)
69. King, J. A., and Mavromatis, A. The effect of a conflict situation on learning ability in two strains of inbred mice. *J. Comp. Physiol. Psychol.*, **49**, 465-68 (1956)
70. Kish, G. B., and Antonitis, J. J. Unconditioned operant behavior in two homozygous strains of mice. *J. Genet. Psychol.*, **88**, 121-29 (1956)
71. Knox, W. E., and Messinger, E. C. The detection in the heterozygote of the recessive gene for phenylketonuria. *Am. J. Human Genet.*, **10**, 53-60 (1958)
72. Krech, D., Rosenzweig, M. R., and Bennett, E. L. Dimensions of discrimination and level of cholinesterase activity in the cerebral cortex of the rat. *J. Comp. Physiol. Psychol.*, **49**, 261-68 (1956)
73. Krech, D., Rosenzweig, M. R., Bennett, E. L., and Krueckel, B. J. Enzyme concentrations in the brain and adjustive behavior patterns. *Science*, **120**, 994-96 (1954)
74. Levine, L. Studies on sexual selection in mice. I. Reproductive competition between albino and black-agouti males. *Am. Naturalist*, **92**, 21-26 (1958)
75. McClearn, G. E. Performance differences among mouse strains in a learning situation. *Am. Psychologist*, **13**, 405 (Abstr.) (1958)
76. McClearn, G. E. The genetics of mouse behavior in novel situations. *J. Comp. Physiol. Psychol.*, **52**, 62-67 (1959)

77. Mahut, H. Breed differences in the dog's emotional behavior. *Can. J. Psychol.*, **12**, 35-44 (1958)
78. Mandl, A. M. The value of littermate controls in endocrinological research. In *Laboratory Animal Bureau, Collected Papers*, **3**, 49-57 (Laboratory Animal Bureau, London, England, 1955)
79. Merrell, D. J. Dominance of eye and hand. *Human Biol.*, **29**, 314-28 (1957)
80. *The Nature and Transmission of the Genetic and Cultural Characteristics of Human Populations* (Milbank Memorial Fund, New York, N. Y., 143 pp., 1957)
81. Miller, S. Competitive mating in inbred strains of mice. *Biol. Rev. for C. C. N. Y.*, **20**, 8-16 (1958)
82. Mirone, L. The effect of alcohol on growth and voluntary consumption of alcohol by successive generations of mice. *Quart. J. Studies Alc.*, **19**, 388-93 (1958)
83. Mitsuda, H. Klinisch-Erbiologische Untersuchung der endogen Psychosen. *Acta. Genet.*, **7**, 371-77 (1957)
84. Nisbet, J. D. Intelligence and family size. *Eugenics Rev.*, **49**, 201-2 (1958)
85. Pawlowski, A. A., and Scott, J. P. Hereditary differences in the development of dominance in litters of puppies. *J. Comp. Physiol. Psychol.*, **49**, 353-58 (1956)
86. Pearson, J. S., and Kley, I. B. On the application of genetic expectancies as age-specific base rates in the study of human behavior disorders. *Psychol. Bull.*, **54**, 406-20 (1957)
87. Prosser, C. L. Physiological variation in animals. *Biol. Rev.*, **30**, 229-62 (1955)
88. Richter, C. P. The effects of domestication and selection on the behavior of the Norway rat. *J. Natl. Cancer Inst.*, **15**, 727-38 (1954)
89. Richter, C. P., and Rice, K. K. Comparison of the effects produced by fasting on gross bodily activity of wild and domesticated Norway rats. *Am. J. Physiol.*, **179**, 305-8 (1954)
90. Richter, C. P., and Uhlenhuth, E. H. Comparison of the effects of gonadectomy on spontaneous activity of wild and domesticated Norway rats. *Endocrinology*, **54**, 311-22 (1954)
91. Riss, W. Sex drive, oxygen consumption and heart rate in genetically different strains of male guinea pigs. *Am. J. Physiol.*, **180**, 530-34 (1955)
92. Riss, W., Valenstein, E. S., Sinks, J., and Young, W. C. Development of sexual behavior in male guinea pigs from genetically different stocks under controlled conditions of androgen treatment and caging. *Endocrinology*, **57**, 139-46 (1955)
93. Roderick, T. E. The genetics of variation of cholinesterase activity in the cerebral cortex of the rat with reference to possible physiological and morphological correlation (Doctoral thesis, Univ. of Calif., Berkeley, Calif., 1959)
94. Roe, A., and Simpson, G. G. *Behavior and Evolution* (Yale University Press, New Haven, Conn., 557 pp., 1958)
95. Rosenzweig, M. R., Krech, D., and Bennett, E. L. Brain enzymes and adaptive behavior. In *Ciba Foundation Symposium. Neurological Basis of Behavior*, 337-55 (Little, Brown & Co., Boston, Mass., 400 pp., 1957)
96. Rosenzweig, M. R., Krech, D., and Bennett, E. L. Acetylcholine metabolism and behavior of rats. *Science*, **129**, 62-64 (1959)
97. Rosenzweig, M. R., Krech, D., Bennett, E. L., and Longueil, C. L. Strain

- differences of rats in behavior and brain chemistry. *Am. Psychol.*, **13**, 405 (Abstr.) (1958)
98. Ross, S., Ginsburg, B. E., and Denenberg, V. H. The use of the split-litter technique in psychological research. *Psychol. Bull.*, **54**, 145-51 (1957)
99. Rothenbuhler, W. C. Genetics of a behavior difference in honeybees. *Proc. Intern. Congr. Genet., 10th Meeting*, **2**, 242 (Montreal, Canada, 1958)
100. Royce, J. R. Factor theory and genetics. *Educ. Psychol. Measurement*, **17**, 361-76 (1957)
101. Sarason, S. B., and Gladwin, T. Psychological and cultural problems in mental subnormality: a review of research. *Genet. Psychol. Monographs*, **57**, 63-78 (1958)
102. Scott, J. P. The effects of selection and domestication upon the behavior of the dog. *J. Natl. Cancer Inst.*, **15**, 739-58 (1954)
103. Scott, J. P. *Aggression* (University of Chicago Press, Chicago, Ill., 149 pp., 1958)
104. Scott, J. P. *Animal Behavior* (University of Chicago Press, Chicago, Ill., 281 pp., 1958)
105. Scott, J. P., and Charles, M. S. Genetic differences in the behavior of dogs: a case of magnification by thresholds and by habit formation. *J. Genet. Psychol.*, **84**, 175-88 (1954)
106. Scott, J. P., and Fuller, J. L. Heredity and the development of social behavior traits in dogs. *Acta Psychol.*, **15**, 554-55 (1959)
107. Shields, J. Personality differences and neurotic traits in normal twin school children: a study in psychiatric genetics. *Eugenics Rev.*, **45**, 213-46 (1954)
108. Shields, J. Twins brought up apart. *Eugenics Rev.*, **50**, 115-23 (1958)
109. Sinha, S. N., Franks, C. M., and Broadhurst, P. L. The effect of a stimulant and a depressant drug on a measure of reactive inhibition. *J. Exptl. Psychol.*, **56**, 349-54 (1958)
110. Slater, E. The monogenic theory of schizophrenia. *Acta Genet. Stat. Med.*, **8**, 50-56 (1958)
111. Smith, J. M. Fertility, mating behavior and sexual selection in *Drosophila subobscura*. *J. Genet.*, **54**, 261-79 (1956)
112. Snyder, L. H. The effects of selection and domestication on man. *J. Natl. Cancer Inst.*, **15**, 759-69 (1954)
113. Stamm, J. S. Genetics of hoarding. I. Hoarding differences between homozygous strains of rats. *J. Comp. Physiol. Psychol.*, **47**, 157-61 (1954)
114. Stamm, J. S. Hoarding and aggressive behavior in rats. *J. Comp. Physiol. Psychol.*, **48**, 324-26 (1955)
115. Stamm, J. S. Genetics of hoarding. II. Hoarding behavior of hybrid and back-crossed strains of rats. *J. Comp. Physiol. Psychol.*, **49**, 349-52 (1956)
116. Tebb, G., and Thoday, J. M. Reversal of mating preference by crossing strains of *Drosophila melanogaster*. *Nature*, **177**, 707 (1956)
117. *Proc. Intern. Congr. Genet., 10th Meeting* (Montreal, Canada, 1958)
118. Thompson, W. R. The inheritance and development of intelligence. *Proc. Assoc. Research Nervous and Mental Disease*, **33**, 209-31 (1954)
119. Thompson, W. R. Traits, factors, and genes. *Eugenics Quart.*, **4**, 8-16 (1957)
120. Thompson, W. R., and Kahn, A. Retroaction effects in the exploratory activity of "bright" and "dull" rats. *Can. J. Psychol.*, **9**, 173-82 (1955)

121. Trankell, A. Aspects of genetics in psychology. *Am. J. Human Genet.*, **7**, 264-76 (1955)
122. Tyler, L. E. *The Psychology of Human Differences*, 2nd ed., (Appleton-Century-Crofts, Inc., New York, N. Y., 562 pp., 1956)
123. Valenstein, E. S., Riss, W., and Young, W. C. Sex drive in genetically heterogeneous and highly inbred strains of male guinea pigs. *J. Comp. Physiol. Psychol.*, **47**, 162-65 (1954)
124. Valenstein, E. S., Riss, W., and Young, W. C. Experiential and genetic factors in the organization of sexual behavior in male guinea pigs. *J. Comp. Physiol. Psychol.*, **48**, 397-403 (1955)
125. Vandenberg, S. C. The hereditary abilities study: the University of Michigan. *Eugenics Quart.*, **3**, 94-99 (1955)
126. Waddington, C. H., Woolf, B., and Perry, M. M. Environment selection by *Drosophila* mutants. *Evolution*, **8**, 89-96 (1954)
127. Warren, J. M. The development of paw preferences in cats and monkeys. *J. Genet. Psychol.*, **93**, 229-36 (1958)
128. Williams, R. J. *Biochemical Individuality. The Basis for the Genetotropic Concept* (John Wiley & Sons, Inc., New York, N. Y., 214 pp., 1956)
129. Wood-Gush, D. G. M. Genetic and experiential factors affecting the libido of cockerels. *Proc. Roy. Soc. Edinburgh*, **27**, 6-7 (1958)
130. Wood-Gush, D. G. M., and Osborne, R. A study of differences in the sex drive of cockerels. *Brit. J. Animal Behavior*, **4**, 102-10 (1956)

ENGINEERING PSYCHOLOGY¹

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This second review of engineering psychology emphasizes the scientific and professional aspects within psychology of a broad interdisciplinary area of applied science variously called human engineering, human factors engineering, biomechanics, biotechnology, ergonomics, or just human factors research and development. Obviously, there continues to be terminological confusion, if not anarchy, among those identified with the area.

Following Fitts (53), the emphasis of this review is placed on the identification of human performance functions which are relevant, not only to the initial design (or redesign) of equipment components of man-machine systems, but also to the determination of operational procedures and work environments for the human operator. Explicitly excluded are basic and applied studies relating to the selection and training of human operators.

While this exclusion has certain practical merits, and is, in fact, reflective of a frequent neglect of individual differences and training variables in engineering psychology research and applications, it should be recognized that the qualities of personnel and kinds of training determine human capabilities and limitations, and that they must be considered in the design of man-machine systems, operating procedures, and work environments. As Melton (118) has pointed out, both engineering psychology applications and personnel and training research applications must draw upon scientific psychology without arbitrary or bureaucratic restriction, if effective and efficient man-machine systems are to be devised, even though the user of the engineering psychology recommendations is the systems engineer and the user of the personnel and training recommendations is the personnel system manager. Haire (72) has also made this point effectively in discussing engineering psychology as a part of business and industrial psychology, while Christensen (39) makes the point in a paper on trends in human factors work.

The present review is necessarily limited to normal publication media plus formal, numbered publication series from government laboratories, and excludes publications by industry. Even so, more than half of the references cited are not accessible in established journals—a situation that makes bibliographies especially important even though assembled with appreciable lag. Following McCollom & Chapanis' 1956 bibliography (112) of 5666 articles, there is now a *Human Engineering Bibliography* of articles published

¹ The survey of the literature pertaining to this review covers the period from June, 1957 through May, 1959.

in 1955-1956 (82) and also a second volume (for 1953) of an annotated bibliography of aviation medicine (84). In addition, Allen & Saul (3) have performed a valuable service by assembling a bibliography of bibliographies in the area. Justice is served when government supports the publication of bibliographies to remedy its own myopic publication practices in science.

In spite of the identification of many psychologists with the area, McCormick (113) has published the only text on human engineering in the past two years. However, Broadbent's *Perception and Communication* (30) is an important systematic contribution to engineering psychology, and Chapanis' (34) *Research Techniques in Human Engineering* and Attneave's (11) *Applications of Information Theory to Psychology* will be useful.

PROFESSIONAL ACTIVITIES

Work at both professional and scientific levels in engineering psychology continues to expand at a rapid rate. In a recent study of "human factors professional personnel" in industry (148), 55 organizations reported the employment of 666 professional personnel, of which 453 (68 per cent) were in psychology. The findings of Kraft (105) in another survey are compatible. Educational programs to supply such numbers of specialists are described by Warren (152).

Two professional organizations now exist in this country for engineering psychologists. They are the Society of Engineering Psychologists—a Division of the American Psychological Association—and The Human Factors Society. The latter is perceived as an international society to provide an opportunity for all specialists (psychologists, anthropologists, medical scientists, engineers, etc.) with interests in human factors engineering to meet on common ground. It is, therefore, the American counterpart, at least for engineering psychologists, of the Ergonomics Research Society, which has its home in England. These two societies now publish journals (*Human Factors* and *Ergonomics*, respectively) which will begin to serve the needs of engineering psychologists, but available journal space remains completely inadequate. The *Human Factors Society Bulletin* (140) appears monthly and carries items of professional interest.

MAN IN SPACE

Engineering psychology is naturally quite responsive to the changing needs of modern technology. Thus, such present and near-future systems as those for missile launch, atomic powered aircraft, and manned space vehicles place heavy demands on the human operator, whether he is to prepare the vehicle for launch or to be an operator-passenger. Relevant reports are: Adams (2), on instrumentation for laboratory research on extended flight endurance data; Bamford *et al.* (17), on human factor problems in the operation of manned space vehicles; Bamford, Hanes & Wilson (18), on the missions of manned military aircraft; Kopstein & Morgan (104), on the human factor in ballistic missile systems; and the symposium report on human control dynamics in air and space craft edited by Smith (141).

Space travel is being approached with well-substantiated research methodologies and no one has suggested that we need divorce these methodologies from those of the past, nor is it felt that we are in need of a unique "space psychology." Rather, it is apparent that the human factor problems of space travel represent extreme ranges of behavioral variables long studied at their lesser extreme points by the psychologist.

Indeed, the space age should be both a challenge and a source of satisfaction to engineering psychologists. Since the space vehicle will have radically different control characteristics and requirements, as compared to present-day aircraft, there should be considerably less resistance to instrumentation which conforms to human requirements more than to tradition.

STRESS

The advent of supersonic aircraft, high-speed atomic powered submarines, and the near-future atomic powered aircraft and manned space vehicles has accelerated research on conditions loosely identified as stressful. Chiles (36) reviews previous interpretations and definitions of the stress concept. It would appear that stress may be defined by at least three somewhat independent operations: physiological stress, which arises under such conditions as extremes of temperature, oxygen deprivation, and rapid acceleration in space; psychological stress, which occurs under conditions of complete sensory deprivation, physical isolation, intense sensory stimulation, and threats of bodily harm; and task-induced stress, which occurs when radical changes take place in the task requirements or conditions of control confronting the operator in a task-oriented situation. Representative research on each of these topics will now be considered.

Physiological stress.—Interest in the physiological effects of acceleration stress has been high, but relatively few reports are available on performance decrements with nonnormal g (gravitational pull). White (153) has reviewed the literature on the effects of both positive and negative g stress on human visual responses. The research dealt both with gross qualitative changes (loss of peripheral vision, red-out, black-out, and the occurrence of retinal hemorrhage) and with the influence of high g on absolute visual thresholds, visual acuity, and critical fusion frequency (CFF). Progressive decrements in photopic and scotopic sensitivity and in visual acuity occur with increasing acceleration stress, but CFF seems to be considerably more resistant to changes than these other functions.

White & Riley (154) investigated the effect of acceleration stress (1, 2, 3, and 4 g) on the relation between illumination level (0.004 m.L. (millilamberts) to 42 m.L.) and the accuracy of dial reading responses. Errors increased with increasing g , but the effects of g could be compensated by increasing illumination. Similar results were found by Brown & Burke (31) with visual reaction time to two levels of luminance (0.025 m.L. and 4560 m.L.) of white light, a less complex task.

Fletcher, Collins & Brown (57) determined performance in a two-dimensional tracking task as influenced by: (a) location of the control column (in

front or to the right of the operator); (b) level of acceleration at the 91st and 111th sec. of a 141-sec. trial (1, 2, 3, or 4 g); and (c) pattern of acceleration stress. Performance deteriorated with 3 and 4 g, was superior with the side control, and deteriorated more with 30-sec. accelerations than with 10-sec. accelerations. In a second study by Brown & Collins (32), Ss not only tracked a two-dimensional input, but control column movements also affected the positioning of the centrifuge gondola. Tracking performance again deteriorated with $g > 1$, but Ss were able to make appropriate movements to control the gondola and thus avoid the stressful accelerations (up to $2\frac{1}{2}$ g).

Thermal stress has received attention in two reports by Chiles (37, 38). In both experiments, Ss were required to report the number of different elements in a series of stimulus cards. In neither study was there a significant change in performance as a result of increases in temperature (from 76° to 91° F. and from 85° to 120° F. [dry bulb], respectively, in the two studies). As these results do not agree with earlier reports, Chiles proposes that temperature extremes are not likely to influence performance if the task requires a high level of alertness and has been well learned prior to thermal stress.

Psychological stress.—Intense sensory stimulation—specifically, noise—is the only manipulation of psychological stress, as defined, that has been used in conjunction with observations of task performance during the period covered by this report. The results achieved are suggestive, but not easily integrated.

Jerison (88) compared performance on a Mackworth (three-clock) vigilance task, a counting task, and a temporal estimation task under "noise" (114 or 111.5 db) and "quiet" (83 or 77.5 db). Vigilance and temporal estimation were adversely affected by noise, but performance in the counting task was degraded by "noise" only when it preceded the "quiet" condition. This interaction of the stressful effects of noise and amount of previous experience with the task is consistent with results reported by Broadbent (28, 29) and Azrin (12) and also with Chiles' (36) hypothesis, as noted above, about the effects of thermal stress.

However, other recent experiments give conflicting results on the effects of noise. Jerison & Wallis (91) had Ss monitor a one-clock Mackworth apparatus for $1\frac{1}{2}$ hr. under conditions of "noise" (112.5 db) and "quiet" (79 db), and found no significant difference in performance under those two conditions. These authors argue that both the one- and three-clock vigilance tasks require alertness, but only the three-clock task requires flexibility of attention; they hypothesize that noise is stressful only to tasks involving flexibility of attention.

Whether this hypothesis can be made to fit the data of Jerison, Crannell & Pownall (90) and Jerison & Arginteanu (89) cannot be determined. They studied the effects of noise and quiet, approximately as previously defined, in a time-estimation task in which the coincidence of a pip and a hair-line had to be estimated after the pip had disappeared from the field of view. Noise present in both the observing and estimating periods did not influence

the over-all accuracy of estimates, nor was there an interaction between the effects of noise and the level of training in the task. When noise was present during the observation period and absent during the estimation period, or vice versa, the temporal intervals were sometimes overestimated and sometimes underestimated, but these effects could not be fitted into a systematic theory based on the task conditions.

In a study of the effects of noncontingent noise, stimulus-contingent noise, and response-contingent noise on observing responses in the Holland (79) vigilance task, Azrin (12) concludes that the performance effects of noncontingent noise (such as used in other studies cited here) are trivial compared to the effects of response-contingent noise, where noise serves as punishment for the observing response. Performance was, however, degraded by the onset of noncontingent noise—and by its offset—and the effect decreased with repeated occurrences.

Task-induced stress.—As indicated earlier, task-induced stress is occasioned by marked changes in the task requirements, per se. Two recent reports are representative. Garvey & Henson (63) studied a simple lag-free tracking task with display gain (range of 6.7 to 1 in five steps) and task-induced stress as parameters. The stressful tasks included a secondary arithmetic task, an incompatible display-control relation, two-hand tracking, two-coordinate tracking, or a secondary visual detection task. Two measures of performance were recorded: system-error (the error signal prior to the display gain operation) and display-error (the error signal subsequent to the gain operation and as seen by S). Task-induced stress produced a marked deterioration of performance in terms of both measures.

In a subsequent report by Garvey & Taylor (67), the interactions of operator variables, system dynamics, and task-induced stress were systematically explored as representative of selection, training, and human engineering variables in system efficiency. In Experiment I they manipulated a human engineering variable, quickening. One of two matched groups tracked a complex sinusoid through acceleration (Type II) dynamics while the other tracked the same input with an acceleration-aided system. As usual, the group that received the quickened feedback signal performed at a superior level. Under stress operations similar to those employed by Garvey & Henson (63), both groups deteriorated significantly in tracking performance, but the deterioration was relatively greater for the nonquickened system. In Experiment II the Ss were selected so as to eliminate the difference noted in Experiment I between the acceleration and acceleration-aided systems during the unstressed trials and, thus, equate performance levels on the two systems by selection procedures. Performance on both systems again deteriorated when stress operations were introduced. Further, although the amount of deterioration for the acceleration system was somewhat greater than that for the acceleration-aided system (the latter being operated by the poorer Ss), there was no significant difference between the two systems during the stress trials. Thus, selection and human engineering variables interact to determine per-

formance levels, both relative and absolute, under conditions of stress. In Experiment III Garvey & Taylor equated performance on two control systems by training. Here they employed a positional (Type O) and an acceleration control system. Initial performance was better in the group tracking through positional dynamics, but training was continued until performance levels became comparable; then the stress operations were introduced. Again, under stress, performance deteriorated for both groups, but the group using the acceleration system deteriorated to the greater extent. Garvey & Taylor conclude: "... the 'engineering' variable of system dynamics proved to be ascendent over the 'psychological' variables of selection and training in determining relative performance under stress" (67, p. 84). A similar conclusion was reached in two previous reports by Garvey (62) and Taylor & Garvey (150).

Task-induced stress has not been given proper weight by those who have decided against certain engineering psychology recommendations in equipment design. The controversy over the inside-out (moving horizon-fixed aircraft) vs. the outside-in (fixed horizon-moving drone) display of aircraft attitude serves to illustrate this point. There is overwhelming evidence from the laboratory that the outside-in display is preferable in that it represents a more compatible display-control relationship than does the standard artificial horizon attitude indicator. Original objections to the suggested modification were based on questions of possible confusion by pilots trained to interpret the older display. This objection was met by showing that negative transfer was not important. Narva (125) adds further substantiation to this conclusion in a study in which Ss made a choice of control actions needed to correct aircraft attitudes shown in three types of display. There were no differences among conditions for nonpilots; decisions by pilots were more rapid with an outside-in and a "mixed" display than with the highly overlearned inside-out display.

Recently, Svimonoff (146) suggested that the inside-out display might involve less task-induced stress because it is appropriate to both IFR (instrument flight rules) and VFR (visual flight rules) conditions, and because the pilot, when airborne, becomes part of the aircraft (he straps the aircraft on his back) and thus it is the horizon which "moves," not the aircraft. The arguments will continue, but data also continue to accumulate. Gardner *et al.* (60) have compared the moving horizon (fly to) and fixed horizon (fly from) displays for instrument landing approaches in a C-47 aircraft where the pilot is under task-induced stress due to the critical control activity required. The outside-in display was superior. Gardner (59) has also found the "fly-from" motion relationship superior to the "fly-to" relationship in tracking a simulated cross-pointer display. No interaction of the display-of-motion relationship and rate of movement of the pointers was found, even though the latter variable was inversely related to performance.

Conklin & Lindquist (42) provide data on this display controversy when Ss are suffering physiological stress. They rotated experienced pilots to induce

vertigo, and then had them attempt to restore a simulated aircraft to normal from a series of unusual attitudes. Under vertigo stress, the moving drone display was significantly superior to the usual inside-out display, both in terms of reversal errors and recovery time. Also, negative transfer effects between the two types of attitude display were either absent or negligible.

Although task-induced stress is certainly not the only factor that needs to be considered in the engineering of dynamic displays [see Ritchie & Baker (130)], it is clearly an important factor to be considered in such decisions. Also, it may be possible to reduce task-induced conflict by the design of an attitude instrument that is intermediate between the "inside-out" and "outside-in" displays, as suggested by Fogel (58).

INFORMATION DISPLAY VARIABLES

Legibility and visibility.—Optimal numeral form continues to be a subject of interest. Squires (144) was concerned with optimal numeral shape for viewing under red illumination conditions, while Soar (143) compared several numeral shapes under short, 40 msec.-exposure conditions. Each author reached conclusions regarding optimal numeral form as examined under his conditions.

Crannell & Debons (45, 48) have studied the relative legibility of "scotch-lite" reflective materials, and other materials, with special reference to their use as identification marking on aircraft. The reflex-reflective background was superior to both aluminum and white backgrounds at all viewing angles at extreme viewing distances (500 ft.); "scotchlite" numerals on black backgrounds were superior to black digits on a "scotchlite" background for extreme viewing angles at 250 ft. and for all angles at 500 ft.

Wright & Seminara (156) determined the readability thresholds of letters and numerals backlighted by phosphors which were excited by radioactive materials. The authors varied hue (green, yellow, and blue), brightness of the backlight illuminance (five levels), and the size of the stimulus materials (four sizes). The yellow hue illuminated at 28.8 mL. resulted in the lowest threshold for legibility, while the highest thresholds were recorded for the blue hue. They found no performance differences between conditions of dark or light adaptation.

Three more reports have been released on caution and warning indicators for aircraft [Stirner, Siegel & Baker (145); Baker, Siegel & Stirner (16); and Siegel & Stirner (139)]. These experiments sought to determine the relative effectiveness of auditory vs. visual signals as "attention getting" or "intruding" warning signals and the effects of color and brightness contrasts of visual warning lights. The conclusions include the following of general interest. Auditory signals were moderately more effective than visual signals, and the two together were no more effective than the auditory signal alone; a complex tone (340+1800 c.p.s.) was more effective than either an 1800-c.p.s. tone or a warning light at either 0.17 or 0.78 foot-lambert.

Coding.—The evaluation of a variety of stimulus dimensions continues

to occupy a substantial portion of the research in engineering psychology. This reflects the never-ending need for unique, independent coding dimensions for the display of information to the human operator. In a study by Conover & Kraft (43), 10 Ss made absolute identifications of individual colors from a set of 25 hues drawn from the Munsell 50-hue series of surface colors. An equal discriminability scale was constructed and cross-validated with another sample of Ss. The authors conclude that a maximum of eight surface colors should be used for coding if only a small number of errors is tolerable in absolute identification of hue codes, and if this code is to be used for somewhat more than half the population. They suggest that a smaller number of colors may be required for near-perfect operations under most practical conditions. Other research on the absolute judgment of color-coded lights has been reported by Halsey (75, 76).

Cohen & Dinnerstein (41) further illustrate the utility of equal discriminability scaling procedures in developing codes. Their Ss made absolute judgments of flash rates from 1 per sec. to 12 per sec. Only five categories (rates) could be discriminated without error. Klemmer (102) has used a flashing signal and key-pressing responses to determine the human capability for transmission of information encoded in time only.

The validity of the equal discriminability scaling technique was further confirmed by Alluisi & Sidorsky (6) in an extensive analysis of the discrimination of small circles of light which varied in size. Sabeh, Jorve & Vanderplas (136) present some initial data on the possible use of shape coding for critical sectors of information displays. Torre & Sanders (151) report an interesting but not very successful attempt to determine plan position indicator scope symbols for "hostile," "friendly," and "unknown" pips in anti-aircraft systems on the basis of population stereotypes for visual symbols; Dardano & Donley (46) obtain decreasing discriminabilities for a cross-in-a-circle, a cross, a circle, $\frac{1}{2}$ circle, and $\frac{3}{4}$ circle, in the order given, when used for the same purpose; and Dardano & Stevens (47) have studied discriminability of the first four of the forms just listed as a function of variations in size between $\frac{1}{8}$ in. and $\frac{1}{2}$ in. with normal viewing of a plan position indicator scope console.

Alluisi & Martin (4) and Alluisi & Muller (5) provide basic data on the compatibility of several stimulus-response pairings of various symbolic codes and both verbal and motor responses. Bowen, Andrews & Ross (22) explored stimulus-response compatibility as a function of pretraining, stimulus coding, and warm-up. Anderson & Fitts (8) provide basic data on color and shape as coding dimensions of symbolic stimuli. They noted a maximum average information transmission with color of 10.44 bits per exposure and with numerals 14.94 bits. When color-numeric symbols were employed, the informational analysis revealed that maximum information transmitted was 18.64 bits. While this was significantly greater than either of the single coding dimensions, it is less than what one might predict by combining the information transmission data of the two independent dimensions of

coding. Finally, Pollack (128) reports experiments with auditory and visual displays which show that increasing the number of display-variables (e.g., frequency, loudness, duration, intermittency) per display-element (a cluster of display-variables, none repeated), or increasing the number of display elements, results in improvement in the amount of information transmitted. However, subdivision of a display variable adds very little to the information transmitted in such displays.

Although treated very sketchily, Pollack (128) also formulates a language for description of display coding (display-variable, display-element, multi-variant display, and multi-element display), which faces up to this persisting problem of research on displays and display coding. Conceptualization and research such as his is sorely needed if research on the coding of information for human use is to rise above the single-dimensional or two-dimensional analysis, and if the coding problem is to be attacked experimentally in anything like its real-life complexity. The coding of maps and charts is a case in point.

Maps and charts.—One of the most neglected problems in the display of information is the encoding of information on maps and charts. It is generally agreed that information overload is frequently present on static maps and charts. Likewise, there is general acceptance of the practical rule that the information on such maps and charts should be selective with respect to the purpose for which the display is to be used. Nevertheless, systematic experimentation with content-use relationships and with the coding of the necessary content is rare indeed. An exception is the work of Lichte and his collaborators. Lichte *et al.* (108) have reviewed the scattered basic and applied literature pertinent to the problem of determining the optimum characteristics of radar-target charts. Lichte (107) and Lichte, Miller & Borreson (109) then made experimental studies of the scale, size of symbols, amount of information, and aspect-angle information of radar charts when they were used for aiming-point identification and for the recognition of cities. The findings were complex and not too stable, but the studies represent a step in an important direction.

In a basic research study which seems related to this problem, among others, Baker & Morris (14) report the startling finding that patterns of elements in a 10,000-element square matrix are detected with greater speed and accuracy the less the resolution in the whole display, and with greater speed the less the resolution difference between the standard (to-be-detected) and alternate forms. The authors interpret these findings as effects of detail overload under conditions of high resolution. However, theory can wait until this unexpected finding is completely reported, and, perhaps, until it has withstood the test of the replications that it deserves.

Linear and nonlinear scales.—It is gratifying to engineering psychologists to note [Svimonoff (146)] that in the Air Force integrated flight instrument panel the display of airspeed and altitude information for the supersonic F-106 will be vertical moving-tape types, a radical change from the multi-

dial instruments of the past. Further research supports this implementation of past research.

In three related studies by Mengelkoch & Houston (120, 121, 122), Ss executed standard maneuvers in a modified Link trainer with altitude indicated by moving tapes and by standard three-pointer dials. Performance with the tape display was equal to, or better than, that with the standard instrument when proper scale units were used. Elkin (50) has shown that the open-window (tape) display is superior to a simple one-pointer circular display and the circular display is superior to the vertical display, in the speed and accuracy of quantitative readings, but that the circular and vertical displays are superior to the open-window display when qualitative (high, low, OK) readings are required. Thus, the generalization about dial vs. moving-tape display is both extended and qualified.

Cohen & Dinnerstein (40) provide another in a series of reports on the effectiveness of nonlinear scales for information displays. In a check-reading task, a linear scale was superior to three different logarithmic scales in terms of error, but one of the logarithmic scales was read slightly faster than the linear scale. The authors conclude that there is no necessary difficulty in reading a logarithmic scale accurately and rapidly, provided that the scale is not extremely skewed.

Tracking and prediction.—Gordon (70) provides data on tracking performance as a function of degradation of selected information signals on a visual display. In one condition, S attempted to track a previously-learned target course when the target indicator was withdrawn from view. This represents degradation of the input information. In another condition, the output information was similarly degraded. These two conditions were compared to normal pursuit and to normal compensatory tracking performance, the latter representing partial degradation of both input and output information. The results indicated that degradation of input information led to the greatest deterioration in performance, while tracking with degraded output information was only slightly worse than that with the compensatory display.

Garvey, Knowles & Newlin (64) studied the prediction of future target position in a linear-polar display (like the usual plan position indicator radar display), a nonlinear polar display, and linear and nonlinear Cartesian-coordinate displays. With a variety of courses, speeds, and shapes of target, the linear polar-coordinate display provides the most accurate over-all performance, while both Cartesian-coordinate displays provide the least proficient predictions. In a somewhat related study, Hufford & Sidowski (81) have compared four methods of marking the rectangular grid displays in the Navy's Pilot Automatic Dead Reckoning Equipment. Speed and accuracy of plotting performance were influenced by range scale and grid markings, and there was a significant interaction of these variables.

Bowen & Chernikoff (23) studied the effects of input velocity and display magnification on tracking proficiency in order to eliminate the confounding of velocity and frequency of input signals in previous research on display mag-

nification. They held constant the product of frequency and amplitude and varied systematically the input velocity for a set of single sinusoid courses (2, 8, and 30 c.p.m.). The authors conclude that the input variations in velocity had a more profound influence in tracking performance than did display magnification in the range of values studied.

Summary reports.—Useful summaries of research on vision and visual display variables have been provided by Svimonoff (146) on the Air Force integrated instrument panel, by Hake (73) on pattern vision, and by Wulfeck, Weisz & Raben (157) on vision in military aviation. The last named is a handbook which provides summaries of research on air-to-air visibility, air-to-ground visibility, instrument navigation, and other selected topics. Finally, Nicklas (126) provides an informative and comprehensive history of aircraft cockpit instrumentation from 1903 to 1946.

CONTROL VARIABLES

Wearing of gloves.—Considerable attention has been given to the reduction in tactual cues occasioned by operation of control devices while wearing gloves. The report by Bradley (25) is especially significant because of the number of glove characteristics studied. Bradley observed correlations between both operation times and subjective ratings and such glove characteristics as tenacity (resistance to slippage), snugness, suppleness, and protection. He required Ss to manipulate a variety of control devices, including push buttons, toggle switches, knobs, and levers. Significant positive correlations were obtained between tenacity-snugness and operation times and between tenacity-protectiveness and subjective ratings by Ss.

Lyman & Groth (111) make a contribution to the methodology of research in this area by showing that prehensive force is a sensitive index to changes, both in the amount of tactile sensory information available and in physical characteristics of the control device itself. Thus, prehensive force exerted by operators in their transport of objects from one location to another varied significantly as a function of changes in hand covering, distance of movement, and weight of the objects transported. The same authors demonstrate in a second report [Groth & Lyman (71)] that prehensive force varies systematically with the coefficient of friction between the object transported and the fingers (bare or gloved). They found that the greater the friction the less the force exerted.

Jenkins (85) provides some rather remarkable results indicating that, for small knobs, gloved settings of least turns on a linear scale were superior to those made with bare fingers; with larger knobs this superiority was lost. Jenkins could offer no explanation for this unexpected result. Data by Provins (129) provide a possible clue to the failure of gloves to degrade performance in Jenkins' study. Provins demonstrated that cutaneous sensory control over pressure and rate of application of pressure was effective only for pressures below 400 gm. If Jenkins' Ss exerted greater amounts of pres-

sure, then, one would not expect glove insulation to interfere with the knob setting responses.

Characteristics of controls.—Control devices may vary along a number of physical dimensions, including mass, viscosity, friction, etc.

Bradley & Wallis (26, 27) have reported two straightforward studies of time and errors in the on-off operation of pushbuttons and toggle-switches as a function of the spacing between controls and other intrinsic characteristics of the controls. When total space is not a problem, large ($\frac{1}{2}$ in. diameter or larger) pushbuttons with small resistance to operation are recommended; when space is very limited, small toggle-switches with large resistance to operation are recommended.

Rockway (132) and Rockway & Franks (133) provide data on deadspace (free-play in mechanical linkage which is confined to the center position of the control device) and backlash ("floating" or "traveling" deadspace, which occurs whenever control movement is reversed). Rockway systematically varied both deadspace (0, 1, 2, and 3 degrees) and system gain (3:1, 9:1, 18:1), while Rockway & Franks did the same for backlash. Tracking performance deteriorated with increasing amounts of deadspace and backlash and with increasing amounts of gain; there were significant interactions between deadspace and system gain and between backlash and system gain. As Rockway & Franks (133) indicate, the interactions are quite significant for design engineers—a tolerance value (for backlash or deadspace) sufficiently rigorous for a "low gain" cargo aircraft might well be intolerable in a "high gain" fighter aircraft.

Display-control compatibility.—Garvey, Sweeney & Birmingham (66) compared performance in tracking under "control lag" and "display lag" conditions by presenting S with various sigmoid lags between a control device and a visual display. A "control lag" involved a passive filter inserted just after the control column, whereas in the "display lag" the filter was inserted just prior to the visual display. Thus, under the former condition only output signal of S was directly affected by the lag, while under the "display lag" condition both the system input and S's output were so affected. Garvey *et al.* argue that the filter characteristics were such that none of the frequencies of the system input signal would be attenuated and that S should, therefore, perceive no difference under the two conditions. The performance indicant used was system error, which means that, under the "display lag" condition, the error signal was measured prior to its insertion into the filter network. Thus, the signal which S perceived on his tracking display was not the same signal scored under the "display lag" condition, the former being subject to the filtering operation of the lag network.

The results indicated that system performance under both lag conditions deteriorated with increasing lag times but that performance with the "display lag" condition deteriorated significantly more than that with the "control lag." The authors conclude that system performance and operator performance are not synonymous and that "... the difference between system per-

formance under the two types of lag conditions must be attributed to the different ways in which the machine components [lag filters, in this case] process S's noise output relative to system error . . ." (66, p. 10).

In more traditional studies of display-control (stimulus-response) compatibility, Bradley (24) obtained data on direction-of-knob-turn stereotypes in young adult men and women while under various forms of instruction to increase or decrease the brightness of a motionless light. Strong stereotypes (clockwise to increase, counterclockwise to decrease) were found, but the strength varied with the particular form of the instruction (e.g., increase brightness vs. increase dimness). In the same vein, Holding (78) has reported an extensive series of studies of the direction of motion relationships for seven combinations of display pointers moving at right angles to the plane of rotation of a control knob. While certain display-control relationships are clearly preferred in all such studies, it is also clear that these so-called stereotypes differ for stationary and moving displays (therefore for the type of change being controlled), for different forms of instruction to change, and for other specific conditions. These complications arise in one-dimensional display-control relationships; those in two-dimensional relationships have been mentioned earlier in connection with the "fly-to"- "fly-from" problem in cockpit instrumentation.

FEEDBACK VARIABLES

Quickening.—The principle of quickening the display of controlling information continues to stimulate both research and application. Two reports illustrate the basic research devoted to quickening procedures during the period of this review. In one, Chernikoff, Bowen & Birmingham (35) compared tracking performance with a zero-order (positional control) and a fourth-order aided control system when the frequency of the input signal was varied. The results indicated a decided superiority for tracking with the fourth-order aided system for low frequency input signals. However, as course frequency was increased, this superiority was lost, and at high frequencies of input the positional control system became superior. Although these results confound course frequency and system gain for the fourth-order aided control system, they stand as a striking illustration of how quickening can reduce an unmanageable control task to a level which permits highly accurate system performance.

This same result was illustrated by Rund *et al.* (135). With second-order system dynamics, comparison was made of tracking performance under three levels of quickening (partial, full, and super) and two displays of tracking error (continuous and binary). The continuous visual display was superior to the discrete binary display, and the full- and super-quickening procedures significantly improved performance, compared to partial quickening, with both the continuous and the binary displays. Thus, quickening may compensate to some extent for a seriously degraded (binary) feedback.

Illustrations of the effectiveness of the quickening principle when applied

to operational tasks are contained in three reports. Sweeney, Bailey & Dowd (147) and Bailey (13) studied the effectiveness of quickening instrumentation for hovering operations in a simulation of helicopter controls. In terms of error scores, the quickened system was superior to that with an integrated display by a factor of four, and it was superior to that with a conventional display by a factor of six.

Bamford & Ritchie (19) compared performance in an aircraft simulator with a standard turn indicator to that with a combined roll and turn indicator. While this display is not quickened in the sense that all derivative information is combined on a single display element, the principle is similar. The results indicated that the integrated roll and turn display was more effective than the turn indicator in terms of errors in bank and heading.

Feedback specificity.—Hunt (83) has reported an important study of compensatory tracking at two levels of difficulty as a function of four degrees of specificity of information on error (continuous; 13, 7, and 3 categories of error information). Performance improved in a negatively accelerated fashion as the number of categories of information increased, and there was no significant interaction of this relationship and the difficulty of the task. The technique employed for presenting information on error is ingenious and simple. It may be adapted to the study of a number of feedback and display problems in which automatic, but discrete, feedback is desired for analytic purposes.

Augmented feedback.—Two reports have been concerned with what is called achievement or augmented feedback—the S receives extra visual or auditory cues or both (clicks, tones, lights) when his controlling performance is within specified accuracy limits. These cues are in addition to the visual information provided on the controller's primary display.

Archer & Namikas (10) used a 60 r.p.m. rotary-pursuit target and presented a 1000-c.p.s. tone when S was on-target. The major variable was the delay in such feedback (0, .2, .4, .8, and 1.6 sec.). There were no significant differences in performance as a function of delay time, which is interpreted by the author to be a consequence of the negligible "reward value" of the tone for their Ss. However, Smode (142) also employed college students in a study of augmented feedback and found such feedback effective. He introduced augmented feedback in a one-dimensional tracking task by providing (a) a decade counter immediately adjacent to the tracking display which cumulated time on target during a tracking trial, and (b) an auditory click which occurred at the rate of 2 per sec. when on target. This was compared to tracking without augmented feedback, the control procedure. Further, there were several transfer conditions following training. The results indicated that augmented feedback during training significantly elevated performance above that of the control procedure. Further, analysis of the transfer-trial performance levels led Smode to conclude that augmented feedback apparently had a major effect on learning in this task; motivational effects may have been influential as well. It would appear that augmented feedback

is a significant technique for controlling operator performance level, and as such could become a desirable feature in a variety of operator tasks.

SKILLED PERFORMANCE

The scientific description of the performance of skills and the conditions thereof is clearly at the interface of engineering psychology and personnel and training psychology, and is properly perceived as such by psychologists working in both areas. Nevertheless, it is beyond the scope of this review to consider all research on the learning of perceptual, motor, and perceptual-motor skills. Therefore, only three topics of particular interest to engineering psychology are considered here.

Theory of skilled performance.—In part because most engineering psychologists are especially sensitive to their need for an adequate descriptive taxonomy of tasks and skills, theory development on skilled performance continues to be one of the most active research areas in engineering psychology. The modes of attack involved are varied and in many cases quite ingenious. The approaches taken range from the molecular research on the psychological refractory phase [Marill (117)] and the study of movement elements in assembly tasks [Annett, Golby & Kay (9); Buffa & Lyman (33); Nadler & Goldman (123, 124)] to molar research, such as the attempts to determine transfer functions (in the engineering sense) for the human operator in a variety of complex control tasks [Hall (74); Seckel *et al.* (138); McRuer & Krendel (114)]. Somewhere between these two levels one finds a variety of approaches, including the factor analytic work by Fleishman (55, 56) and the remarkable methodologies of Garvey & Mitnick (65) and of Knowles, Holland & Newlin (103).

The report by McRuer & Krendel (114) is especially significant in that it describes in detail such classic work as that of Tustin, Russell, and the more recent data of Elkind. Unfortunately, the engineer does not write for the psychologist, and his work on human transfer functions is difficult reading.

The excellent reports by Garvey & Mitnick (65) and by Knowles, Holland & Newlin (103) do not share this difficulty. Garvey & Mitnick applied servo theory to intratrial error data in a simple tracking task. One principle of servo theory states that, for zero error in a control system, the order of control (the number of derivations taken of the input signal) must be one greater than the highest derivative characteristic of the input itself. By examining the change in error during a tracking trial, Garvey & Mitnick were able to infer that adult males begin tracking with a velocity order of control (first-order) and progress with practice (25 days) to an acceleration and perhaps to a Δ -acceleration level (second- and third-order control, respectively). Thus, by the end of training, Ss were estimating at least the second derivative of the input signal in order to generate their tracking response.

While the Garvey & Mitnick method enables one to infer the complexity of the human transfer function (the number of differential transformations), it does not permit one to write that equation since to do so it is necessary

to determine the weights assigned by S to each transformation. The methodology employed by Knowles, Holland & Newlin (103) provides such information. They applied multiple correlation techniques to the error and control device movement data in a simple tracking task. The best prediction from a single variable was obtained with error velocity 0.20 sec. prior to the time of prediction. Even if error, error velocity, and error acceleration are used in combination, error velocity still carries the most weight. The best predictions, however, were attained when both error (and its higher derivatives) and response movement (and its higher derivatives) were employed in combination. In this case, instantaneous error, rather than its first derivative, provides maximum prediction. Thus Knowles, Holland & Newlin have provided a highly accurate method for the analysis of skilled performance in complex control tasks. Further research may reduce the cumbersomeness of the analysis procedures.

Finally, two reports have appeared which summarize and integrate several research topics in skill performance. Ely *et al.* (52) provide a survey of a variety of man-operated skill tasks, a model of tracking tasks, and a detailed set of hypotheses concerning skill performance. Ely, Bowen & Orlansky (51) cover a wide range of topics, including servo theory, displays, machine dynamics, the aiding and quickening principles, etc. Together, these reports provide an excellent introduction to the research and theory of skilled performance in the control of complex vehicular systems.

Complex task simulators.—Engineering psychologists have an interest in training devices for complex skills, not only because they have some problems in common with the design of operational equipment, but also because they frequently serve as research devices for studies of display and control problems *in situ*, as has been evidenced in the studies previously cited. A report by Adams (1) provides a sophisticated discussion of the design and use of flight simulators. Xhignesse (158) describes the characteristics of flight simulators developed by the French. Lybrand *et al.* (110) describe the needs and techniques for the simulation of extracockpit visual cues in contact flight transition training simulators. On a different problem, Biagioni, McKelvey & Mousted (20) describe a simulator for radar mapping displays.

Retention of skills.—Engineering psychologists have an obvious interest in the effects of task characteristics on the difficulty of learning, but they have an even more direct interest in the retentivity of skills as a function of task characteristics because man-machine system effectiveness depends intimately on the maintenance of operator skills, sometimes over long periods of no-practice. The long-time retention of skills has been neglected in research on human learning, but two studies have appeared recently. Mengelkoch, Adams & Gainer (119) measured the performance of Reserve Officers' Training Corps students in an aircraft simulator 4 mo. after completion of training. Their conclusion of particular interest here was that discrete procedural responses were more susceptible to being forgotten than were the continuous flight control responses (banking, maintaining altitude and

airspeed, etc.). Ammons *et al.* (7) studied the retention of a procedural task and a continuous tracking task after intervals of 1 min. to 2 yr. The procedural tasks were again more susceptible to being forgotten. Since the trend in man-machine system design is toward procedural tasks replacing continuous control tasks, these results forewarn of future problems in the maintenance of the human components at peak efficiency.

MONITORING AND VIGILANCE

As the degree of automation in man-machine systems increases, man's role becomes more that of a stand-by controller or monitor-decision maker, especially in highly routine control operations, but also in some operator functions not usually thought of as routine [see Williams & Hopkins (155), below]. This trend has occasioned a considerable amount of research on monitoring and vigilance performance.

Methodology.—Although measurement of scanning and interrogation responses continues to plague the scientist working in this area, several techniques have been developed. Kris (106) describes the electrical recording of eye movements from two pairs of electrodes at each orbit; Blair (21) describes the recording of fixation points by the response of a light-sensitive cell behind the display. The Holland (79) technique requires that S press a button to illuminate an instrument in order to monitor, thereby providing data on vigilance and search. Finally, Mackworth & Mackworth (116) describe a two-camera, closed-loop television system which mixes records of eye movements and the display to permit an observer to view the position of the eye relative to the visual field.

Research.—A large number of reports on extended monitoring behavior has appeared. A brief listing includes reports by Baker (15) in which are described several techniques to bias the search responses of S so as to reduce missed signals; by Garvey (61), who provides data on five coding arrangements for efficient transmission in a vigilance task; by Garvey, Taylor & Newlin (68), on the use of "artificial" signals to improve detection of infrequent "real" signals; by Jerison (86), in which expectancy of duration of a vigil is shown to influence the course of the performance decrement; and by Jerison (88) and Jerison & Wallis (91) on vigilance in noise and in quiet environments, which have been discussed earlier.

Mackworth & Mackworth (115) report an experiment on speed and load variables in a visual search task, in which errors are linearly related to speed when load is constant and, similarly, to load when speed is constant. Kapauf & Powe (92) found greater decrements in performance on an audio-visual check task over a 2-hr. period for Ss with low Air Force Qualification Test scores. Also, the relation between probability of detection and time since the previous detection was U-shaped. Ross, Dardano & Hackman (134) suggest that higher conductance level galvanic skin response is associated with better vigilance performance in a Mackworth clock test. It was also noted that the majority of errors of commission occurred during the first hour

of the 2-hr. session. Howland (80) also recorded errors of commission and omission in a 4-hr. monitoring task. The use of a log book in one group resulted in fewer commission errors but more omission errors, and this difference became progressively greater during the watch period.

Summaries and theory.—Deese (49) provides a comprehensive review of the literature on changes in visual performance after extended periods of visual work. This includes vigilance research (relatively infrequent signals) as well as research on tasks requiring active continuous use of the oculomotor system and more or less continuous "mental" operation. Jerison (87) describes a model for human vigilance in which the probability of detection of rare, or near-threshold, or both, events is related to signal frequency, response frequency, time at work, complexity of the display, and certain operator variables. In another effort to formulate an appropriate theoretical model, Hickey & Blair (77) adopt a feedback model and make a suggestive analysis of research in the area in terms of it.

DECISION MAKING

The trends in man-machine systems also suggest that engineering psychology will have much traffic with decision theory and research in the years to come. There is much talk about this, but there is very little literature on the many new engineering psychology issues so generated, such as: the display of information for determining subjective probabilities and expected values, and techniques for interrogative interactions of man and machine for efficient filtering and collation. Much detailed analysis of specific man-machine system functions will be required before the full significance of man's emerging role can be realized.

One published study faces this issue squarely, even though tentatively and incompletely. Williams & Hopkins (155) have made a detailed analysis of the pilot's task in a sophisticated weapon system in which the pilot serves primarily as a monitor of programmed operations. They conclude that the pilot's decisions are primarily concerned with the detection and recognition of the state of the system. They see, therefore, a relevance of decision theories and, in particular, the Tanner & Swets (149) theory of detection. Significantly, they abstain from a discussion of displays and controls for such future systems pending experimental evidence to support any new rules based upon decision theory.

MULTIMAN-MACHINE SYSTEMS

Man-machine systems research can be differentiated from its parent areas of engineering and experimental social psychology by the emphasis given to the use of man *and* machine components in the accomplishment of a unitary task. Such research requires "system simulation," and the ability to produce realistic task situations and to manipulate task conditions precisely constitutes a formidable achievement for psychological research. It also requires money, equipment, and continuity.

Although this special area continues to grow, this growth is not very apparent to the scientific community at large. An exception is the work on radar air traffic control system, the concepts and methods of which have now been described by Fitts *et al.* (54). Recent work has been focused increasingly on the problem of division of functions within the system, both between men and machines and among the human operators in a multiman system.

Six of the 10 reports published since the last review [Kidd (94); Kidd & Hooper (95); Kidd & Kinkade (96); Kinkade & Kidd (99, 100, 101)] have been devoted to this topic. For example, Kidd & Kinkade (96) compared the systems effects of assignment of responsibility for essential system operations to the radar controller, or to the aircraft pilots, or to both, in a simulated radar approach control system. There was a significant improvement in system performance when pilots were made responsible for initiating their own speed changes and approach vectors, while controllers assumed a monitoring role.

Other topics studied in this program, through the use of real-time complex task simulation, have included research on display problems [Schipper *et al.* (137)], traffic parameters [Kidd *et al.* (98)], system training [Kidd (93)], and performance dynamics during operator changeover and over extended operational periods [Kidd & Kinkade (97)]. Many useful and important findings have resulted from this research program. However, the program is especially noteworthy as a working model for man-machine system research efforts, rather than just as a gleam in an engineering psychologist's eye—of which there have been many.

Other efforts to provide a conceptual framework for systems research are sparse. Roby & Lanzetta (131) have developed a descriptive paradigm to categorize more effectively the activities that are involved in complex information processing and control tasks undertaken by multiman system; Glaser (69) has presented a thoughtful description of the variables involved in the study of task-oriented groups, and Peters & Hussman (127) have presented some relevant thoughts on human factors in the reliability of complex systems.

OVERVIEW

It is clear to those working in the area of engineering psychology, and it should become clear to others, that this vigorous and expanding universe of knowledge has semantic and taxonomic problems which have not been overcome. Nor can they be overcome in any stable way by the ingenuity of organizers of its literature. The roots of these difficulties are many, not the least of them being the semantic and taxonomic problems of experimental psychology, on which engineering psychology depends so heavily and from which it is frequently indistinguishable.

Foremost among deficiencies of this type is the lack of taxonomies of tasks or of skills which, if available, could be the basis for the organization of

major portions of a review such as this, and which is a necessary condition for systematic and confident application of engineering psychology principles to decisions regarding alternative system designs involving different human functions. Since the application of principles of human learning to training problems is also severely hindered by the lack of a taxonomy of tasks [Cotterman (44)] and since systematic research in all aspects of human learning and performance theory needs such a taxonomy, it may well be that this common need will bring together these sometimes artificially segregated branches of psychological science. Engineering psychology could well afford to be the spearhead in this effort since it can never ignore the ways in which the skill or capability of the human operator is modified by the display, control, and context (environmental) factors that define his task.

LITERATURE CITED

1. Adams, J. A. *Some Considerations in the Design and Use of Dynamic Flight Simulators*. AF PTRC TN 57-51, (San Antonio, Texas, 1957)
2. Adams, O. S. *Aircrew Fatigue Problems during Extended Endurance Flight: Phase I. Planning*. AF WADC TR 57-510 (Dayton, Ohio, 1958)
3. Allen, P. S., and Paul, E. V. An annotated bibliography of bibliographies pertinent to the design and use of machines by human operators. *Human Factors*, **1**, 26-44 (Sept., 1958)
4. Alluisi, E. A., and Martin, H. B. An information analysis of verbal and motor responses to symbolic and conventional Arabic numerals. *J. Appl. Psychol.*, **42**, 79-84 (1958)
5. Alluisi, E. A., and Muller, P. F., Jr. Verbal and motor responses to seven symbolic visual codes: a study in S-R compatibility. *J. Exptl. Psychol.*, **55**, 247-54 (1958)
6. Alluisi, E. A., and Sidorsky, R. C. The empirical validity of equal discriminability scaling. *J. Exptl. Psychol.*, **55**, 86-94 (1958)
7. Ammons, R. B., Farr, R. G., Bloch, E., Neumann, E., Dey, M., Marion, R., and Ammons, C. H. Long-term retention of perceptual-motor skills. *J. Exptl. Psychol.*, **55**, 318-28 (1958)
8. Anderson, N. S., and Fitts, P. M. Amount of information gained during brief exposures of numerals and colors. *J. Exptl. Psychol.*, **56**, 362-69 (1958)
9. Annett, J., Golby, C. W., and Kay, H. The measurement of elements in an assembly task—the information output of the human motor system. *Quart. J. Exptl. Psychol.*, **10**, 1-11 (1958)
10. Archer, E. J., and Namikas, G. A. Pursuit rotor performance as a function of delay of information feedback. *J. Exptl. Psychol.*, **56**, 325-27 (1958)
11. Attneave, F. *Applications of Information Theory to Psychology* (Henry Holt & Co., New York, N. Y., 120 pp., 1959)
12. Azrin, N. H. *Some Effects of Noise on Human Behavior*. U. S. Army, Technical Memo 6-58 (Aberdeen, Md., 1958)
13. Bailey, A. W. Simplifying the operator's task as a controller. *Ergonomics*, **1**, 177-81 (1958)
14. Baker, C. A., and Morris, D. F. Form recognition and detail resolution. *Proc. Intern. Congr. Psychol., 15th Meeting*, Brussels, Belgium, 1957, 285-86 (North-Holland Publishing Co., Amsterdam, The Netherlands, 1959)

15. Baker, C. H. Attention to visual displays during a vigilance task: I. Biasing attention. *Brit. J. Psychol.*, **49**, 279-88 (1958)
16. Baker, R. C., Siegel, A. I., and Stirner, F. W. *Caution and Warning Light Indicators for Naval Aircraft: VI. An Experimental Comparison of Visual and Auditory "Master" Signals under Two Levels of Task Complexity*. U. S. Navy, NAMC-ACEL-366 (Philadelphia, Pa., 1958)
17. Bamford, H. E., Hanes, L. F., Ritchie, M. L., and Wilson, S. E. *The Operation of Manned Spacecraft*. AF WADC TR 58-225 (Dayton, Ohio, 1958)
18. Bamford, H. E., Hanes, L. F., and Wilson, S. E. Missions for manned military spacecraft. *Human Factors*, **1**, 16-29 (April, 1959)
19. Bamford, H. E., Jr., and Ritchie, M. L. Complex feedback displays in a man-machine system. *J. Appl. Psychol.*, **42**, 141-47 (1958)
20. Biagioni, J. R., McKelvey, R. K., and Mousted, J. F. *A Radar Mapping Display Simulation and Performance Recording Device*. AF WADC TN 58-210 (Dayton, Ohio, 1958)
21. Blair, W. C. Measurement of observing responses in human monitoring. *Science*, **128**, 255-56 (1958)
22. Bowen, J. H., Andrews, T. G., and Ross, S. Effects of counting and ordering habits on the acquisition of a simple motor skill. *J. Exptl. Psychol.*, **54**, 121-28 (1957)
23. Bowen, J. H., and Chernikoff, R. *The Effects of Magnification and Average Course Velocity on Compensatory Tracking*. U. S. Navy, NRL Rept. 5186 (Washington, D. C., 1958)
24. Bradley, J. V. *Direction-of-Knob-Turn Stereotypes*, AF WADC TR 57-388 (Dayton, Ohio, 1957)
25. Bradley, J. V. *Glove Characteristics Influencing Control Manipulability*. AF WADC TR 57-389 (Dayton, Ohio, 1957)
26. Bradley, J. V., and Wallis, R. A. *Spacing of On-Off Controls: I. Push Buttons*. AF WADC TR 58-2 (Dayton, Ohio, 1958)
27. Bradley, J. V., and Wallis, R. A. *Spacing of On-Off Controls: II. Toggle Switches*. AF WADC TR 58-475 (Dayton, Ohio, 1959)
28. Broadbent, D. E. Effects of noises of high and low frequency on behavior. *Ergonomics*, **1**, 21-29 (1957)
29. Broadbent, D. E. Effect of noise on an "intellectual" task. *J. Acoust. Soc. Am.*, **30**, 824-27 (1958)
30. Broadbent, D. E. *Perception and Communication* (Pergamon Press, Inc., New York, N. Y., 338 pp., 1958)
31. Brown, J. L., and Burke, R. E. *The Effect of Positive Acceleration on Visual Reaction Time*. U. S. Navy, NADC-MA-5712 (Johnsville, Pa., 1957)
32. Brown, J. L., and Collins, C. C. *Air-to-Air Tracking during Closed-Loop Centrifuge Operation*. U. S. Navy NADC-MA-5803 (Johnsville, Pa., 1958)
33. Buffa, E. S., and Lyman, J. The additivity of the times for human motor response elements in a simulated industrial assembly task. *J. Appl. Psychol.*, **42**, 379-83 (1958)
34. Chapanis, A. *Research Techniques in Human Engineering* (Johns Hopkins University Press, Baltimore, Md., 316 pp., 1959)
35. Chernikoff, R., Bowen, J. H., and Birmingham, H. P. *A Comparison of Zero-Order and Fourth-Order Aided Compensatory Systems as a Function of Course Frequency*. U. S. Navy, NRL Rept. 5262 (Washington, D. C., 1959)

36. Chiles, W. D. *Psychological Stress as a Theoretical Concept*. AF WADC TR 57-457 (Dayton, Ohio, 1957)
37. Chiles, W. D. *Effects of Elevated Temperatures on Performance of a Complex Mental Task*. AF WADC TR 57-726 (Dayton, Ohio, 1957)
38. Chiles, W. D. *Effects of High Temperatures on Performance of a Complex Mental Task*. AF WADC TR 58-323 (Dayton, Ohio, 1958)
39. Christensen, J. M. Trends in human factors. *Human Factors*, 1, 2-7 (Sept., 1958)
40. Cohen, J., and Dinnerstein, A. J. *A Comparison of a Linear Scale and Three Logarithmic Scales on the Time for Check Reading*. AF WADC TR 57-63 (Dayton, Ohio, 1958)
41. Cohen, J., and Dinnerstein, A. J. *Flash Rate as a Visual Coding Dimension for Information*. AF WADC TR 57-64 (Dayton, Ohio, 1958)
42. Conklin, J. E., and Lindquist, O. H. Recovery from unusual aircraft attitudes under the influence of vertigo. *J. Appl. Psychol.*, 42, 136-38 (1958)
43. Conover, D. W., and Kraft, C. L. *The Use of Color in Coding Displays*. AF WADC TR 55-471 (Dayton, Ohio, 1958)
44. Cotterman, T. E. *Task Classification: An Approach to Partially Ordering Information on Human Learning*. AF WADC TN 58-374 (Dayton, Ohio, 1959)
45. Crannell, C. W., and Debons, A. *Illumination and Tilt as Factors in the Legibility of Reflex-Reflective Numerals*. AF WADC TR 58-47 (Dayton, Ohio, 1958)
46. Dardano, J. R., and Donley, R. *Evaluation of Radar Symbols for Target Identification*. U. S. Army, Tech. Memo 2-58 (Aberdeen, Md., 1958)
47. Dardano, J. R., and Stephens, J. A. *Discriminability of AAOC Symbols*. U. S. Army, Tech. Memo 4-58 (Aberdeen, Md., 1958)
48. Debons, A., and Crannell, C. W. The legibility of "scotchlite" versus other materials. *J. Appl. Psychol.*, 42, 389-95 (1958)
49. Deese, J. *Changes in Visual Performance after Visual Work*. AF WADC TR 57-285 (Dayton, Ohio, 1957)
50. Elkin, E. H. *Effects of Scale Shape, Exposure Time, and Display-Response Complexity on Scale Reading Efficiency*. AF WADC TR 58-472 (Dayton, Ohio, 1959)
51. Ely, J. H., Bowen, H. M., and Orlansky, J. *Man-Machine Dynamics*. AF WADC TR 57-582 (Dayton, Ohio, 1957)
52. Ely, J. H., Schneider, R., Kelley, C. R., and Channell, R. C. *Tracking Training: I. Approach*. U. S. Navy, NAVTRADEVCE TR 1908-00-1 (Port Washington, N. Y., 1957)
53. Fitts, P. M. Engineering psychology. In *Annual Review of Psychology*, 9, 267-94 (Farnsworth, P. R., and McNemar, Q., Eds., Annual Reviews, Inc., Palo Alto, Calif., 543 pp., 1958)
54. Fitts, P. M., Schipper, L., Kidd, J. S., Shelly, M., and Kraft, C. Some concepts and methods for the conduct of system research in a laboratory setting. In *Symposium on Air Force Human Engineering, Personnel and Training Research*, NAS-NRC Publ. 516, 174-87 (Finch, G., and Cameron, F., Eds., Washington, D. C., 216 pp., 1958)
55. Fleishman, E. A. An analysis of positioning movements and static reactions. *J. Exptl. Psychol.*, 55, 13-24 (1958)
56. Fleishman, E. A. Dimensional analysis of movement reactions. *J. Exptl. Psychol.*, 55, 438-53 (1958)
57. Fletcher, D. E., Collins, C. C., and Brown, J. L. *Effects of Positive Acceleration*

upon the Performance of an Air-to-Air Tracking Task. U. S. Navy, NADC-MA-5807 (Johnsville, Pa., 1958)

58. Fogel, L. J. A new concept: The kinalog display system. *Human Factors*, 1, 30-37 (April, 1959)
59. Gardner, J. F. *The Effects of Motion Relationship and Rate of Pointer Movement on Tracking Performance. AF WADC TR 57-533* (Dayton, Ohio, 1957)
60. Gardner, J. F., Lacey, R. J., Seeger, C. M., and Wade, J. E. *In-Flight Comparison of Pilot Performance on a Standard USAF and an Experimental Instrument Panel. AF WADC TR 57-270* (Dayton, Ohio, 1957)
61. Garvey, W. D. Operator performance as a function of the statistical encoding of stimuli. *J. Exptl. Psychol.*, 54, 109-114 (1957)
62. Garvey, W. D. *The Effects of Task-Induced Stress on Man-Machine System Performance. U. S. Navy, NRL Rept. 5015* (Washington, D. C., 1957)
63. Garvey, W. D., and Henson, J. B. *Interactions between Display Gain and Task-Induced Stress in Manual Tracking Systems. U. S. Navy, NRL Rept. 5204* (Washington, D. C., 1958)
64. Garvey, W. D., Knowles, W. B., and Newlin, E. P. Prediction of future position of a target track on four types of displays. *Can. J. Psychol.*, 11, 93-103 (1957)
65. Garvey, W. D., and Mitnick, L. L. An analysis of tracking behavior in terms of lead-lag errors. *J. Exptl. Psychol.*, 53, 372-78 (1957)
66. Garvey, W. D., Sweeney, J. S., and Birmingham, H. P. Differential effects of "display lags" and "control lags" on the performance of manual tracking systems. *J. Exptl. Psychol.*, 56, 8-10 (1958)
67. Garvey, W. D., and Taylor, F. V. Interactions among operator variables, system dynamics, and task-induced stress. *J. Appl. Psychol.*, 43, 79-85 (1959)
68. Garvey, W. D., Taylor, F. V., and Newlin, E. P. *The Use of "Artificial Signals" to Enhance Monitoring Performance. U. S. Navy, NRL Rept. 5269* (Washington, D. C., 1959)
69. Glaser, R. Descriptive variables for the study of task-oriented groups. In *Current Trends in the Description and Analysis of Behavior*, 1-21 (University of Pittsburgh Press, Pittsburgh, Pa., 242 pp., 1958)
70. Gordon, N. B. Learning a motor task under varied display conditions. *J. Exptl. Psychol.*, 57, 65-73 (1959)
71. Groth, H., and Lyman, J. Effects of surface friction on skilled performance with bare and gloved hands. *J. Appl. Psychol.*, 42, 273-82 (1958)
72. Haire, M. Psychological problems relevant to business and industry. *Psychol. Bull.*, 56, 169-94 (1959)
73. Hake, H. W. *Contributions of Psychology to the Study of Pattern Vision. AF WADC TR 57-621* (Dayton, Ohio, 1957)
74. Hall, I. A. M. *Effects of Controlled Element on the Human Pilot. AF WADC TR 57-509* (Dayton, Ohio, 1958)
75. Halsey, R. M. Identification of signal lights: I. Blue, green, white, and purple. *J. Opt. Soc. Am.*, 49, 45-55 (1959)
76. Halsey, R. M. Identification of signal lights: II. Elimination of the purple category. *J. Opt. Soc. Am.*, 49, 167-69 (1959)
77. Hickey, A. E., and Blair, W. C. Man as a monitor. *Human Factors*, 1, 8-15 (Sept., 1958)

78. Holding, D. H. Direction of motion relationships between controls and displays moving in different planes. *J. Appl. Psychol.*, **41**, 93-97 (1957)
79. Holland, J. G. Human vigilance—the rate of observing an instrument is controlled by the schedule of signal detections. *Science*, **128**, 61-67 (1958)
80. Howland, D. *An Investigation of the Performance of the Human Monitor*. AF WADC TR 57-431 (Dayton, Ohio, 1958)
81. Hufford, L. E., and Sidowski, J. B. *Variables Influencing Operator Performance on a Rectangular Grid Display*. U. S. Navy, NEL Rept. 857 (San Diego, Calif., 1958)
82. Human Engineering Information and Analysis Service. *Human Engineering Bibliography: 1955-1956*. U. S. Navy, ONR Rept. ACR-24 (Washington, D. C., 1957)
83. Hunt, D. P. *Tracking Performance as a Function of Feedback Specificity*. AF WADC TR 58-584 (Dayton, Ohio, 1959)
84. Jacobius, A. J., Wilkins, M. J., Kassianoff, L., Slie, R. B., and Whitehead, S. L. *Aviation Medicine: An Annotated Bibliography, 1953 Literature* (Aero Medical Association, St. Paul, Minn., 354 pp., 1959)
85. Jenkins, W. L. The superiority of gloved operation of small control knobs. *J. Appl. Psychol.*, **42**, 97-98 (1958)
86. Jerison, H. J. *Experiments on Vigilance: Duration of Vigil and the Decrement Function*. AF WADC TR 58-369 (Dayton, Ohio, 1958)
87. Jerison, H. J. *Experiments on Vigilance: The Empirical Model for Human Vigilance*. AF WADC TR 58-526 (Dayton, Ohio, 1959)
88. Jerison, H. J. Effects of noise on human performance. *J. Appl. Psychol.*, **43**, 96-101 (1959)
89. Jerison, H. J., and Argenteau, J. *Time Judgments, Acoustic Noise, and Judgment Drift*. AF WADC TR 57-474 (Dayton, Ohio, 1958)
90. Jerison, H. J., Crannell, C. W., and Pownall, D. Acoustic noise and time judgment in a visual movement projection task, in *Symposium on Air Force Human Engineering, Personnel, and Training Research*, NAS-NRC Publ. 516, 147-54 (Finch, G., and Cameron, F., Eds., Washington, D. C., 216 pp., 1958)
91. Jerison, H. J., and Wallis, R. A. *Experiments on Vigilance: Performance on a Simple Vigilance Task in Noise and in Quiet*. AF WADC TR 57-318 (Dayton, Ohio, 1957)
92. Kappauf, W. E., and Powe, W. E. Performance decrement at an audio-visual checking task. *J. Exptl. Psychol.*, **57**, 49-58 (1959)
93. Kidd, J. S. *A Comparison of Two Methods of Controller Training in a Simulated Air Traffic Control Task: A Study in Human Engineering Aspects of Radar Air Traffic Control*. AF WADC TR 58-449 (Dayton, Ohio, 1958)
94. Kidd, J. S. *A Comparison of One-, Two-, and Three-Man Control Units under Various Conditions of Traffic Input Rate*. AF WADC TR 59-104 (Dayton, Ohio, 1959)
95. Kidd, J. S., and Hooper, J. J. *Division of Responsibility between Two Controllers and Load Balancing Flexibility in a Radar Approach Team: A Study of Human Engineering Aspects of Radar Air Traffic Control*. AF WADC TR 58-473 (Dayton, Ohio, 1958)
96. Kidd, J. S., and Kinkade, R. G. *Air Traffic Control System Effectiveness as a Function of the Division of Responsibility between Pilots and Ground Controllers: A Study in Human Engineering Aspects of Radar Air Traffic Control*. AF WADC TR 58-113 (Dayton, Ohio, 1958)

97. Kidd, J. S., and Kinkade, R. G. *Operator Change-Over Effects in a Complex Task Setting*. AF WADC TR 59-235 (Dayton, Ohio, 1959)
98. Kidd, J. S., Shelly, M. W., Jeantheau, G., and Fitts, P. M. *The Effect of En-route Flow Control on Terminal System Performance: A Study in Human Engineering Aspects of Radar Air Traffic Control*. AF WADC TR 57-663 (Dayton, Ohio, 1957)
99. Kinkade, R. G., and Kidd, J. S. *The Effect of Team Size and Communication Availability on Decision-Making Performance*. AF WADC TR 58-474 (Dayton, Ohio, 1959)
100. Kinkade, R. G., and Kidd, J. S. *The Effect of Procedural Variations in the Use of Target Identification and Airborne Position Information Equipment on the Performance of a Simulated Radar Approach Control System*. AF WADC TR 58-624 (Dayton, Ohio, 1959)
101. Kinkade, R. G., and Kidd, J. S. *The Effect on Performance of Different Proportions of Monitored Elements in a Control System*. AF WADC TR 59-169 (Dayton, Ohio, 1959)
102. Klemmer, E. T. Transmission of information encoded in time only. In *Symposium on Air Force Human Engineering, Personnel, and Training Research*, NAS-NRC Publ. 516, 210-16 (Finch, G., and Cameron, F., Eds., Washington, D. C., 216 pp., 1958)
103. Knowles, W. B., Holland, J. G., and Newlin, E. P. A correlational analysis of tracking behavior. *Psychometrika*, **22**, 275-87 (1957)
104. Kopstein, F. F., and Morgan, R. L. *Human Factors Considerations in the Design Proposals for a Ballistic Missile Unit Proficiency System*. AF WADC TN 57-352 (Dayton, Ohio, 1957)
105. Kraft, J. A. A follow-up survey of human factors research in aircraft, missiles, and supporting industries. *Human Factors*, **1**, 23-25 (Sept., 1958)
106. Kris, E. C. *A Technique for Electrically Recording Eye Position*. AF WADC TR 58-660 (Dayton, Ohio, 1958)
107. Lichte, W. H. *Studies of the Effect upon Aiming-Point Identification of Certain Chart Variables*. AFPTRC TN 58-3 (San Antonio, Texas, 1958)
108. Lichte, W. H., Eason, R. G., Miller, J. G., Borreson, C. R., and Wist, E. *A Review of the Literature Relating to the Scope-Interpretation and Map-Reading Tasks of the Aircraft Observer*. AFPTRC TN 57-110 (San Antonio, Texas, 1957)
109. Lichte, W. H., Miller, J. G., and Borreson, C. R. *The Influence of Chart Scale and Amount of Information on Aiming-Point Identification by Experienced Subjects*. AFPTRC TN 58-2 (San Antonio, Texas, 1958)
110. Lybrand, W. A., Havron, M. D., Gartner, W. B., Scarr, H. A., and Hackman, R. C. *Simulation of Extra-Cockpit Visual Cues in Contact Flight Transition Trainees*. AFPTRC TR 58-11 (San Antonio, Texas, 1958)
111. Lyman, J., and Groth, H. *Prehension force as a measure of psychomotor skill for bare and gloved hands*. *J. Appl. Psychol.*, **42**, 18-21 (1958)
112. McCollom, I. N., and Chapanis, A. *A Human Engineering Bibliography* (San Diego State College Foundation, San Diego, Calif., 128 pp., 1956)
113. McCormick, E. J. *Human Engineering* (McGraw-Hill Book Co., New York, N. Y., 467 pp., 1957)
114. McRuer, D. T., and Krendel, E. S. *Dynamic Response of Human Operators*. AF WADC TR 56-524 (Dayton, Ohio, 1957)

115. Mackworth, N. H., and Mackworth, J. F. Visual search for successive decisions. *Brit. J. Psychol.*, **49**, 210-21 (1958)
116. Mackworth, J. F., and Mackworth, N. H. Eye fixations recorded on changing visual scenes by the television eye-marker. *J. Opt. Soc. Am.*, **48**, 439-45 (1958)
117. Marill, T. The psychological refractory phase. *Brit. J. Psychol.*, **48**, 93-97 (1957)
118. Melton, A. W. Military psychology in the United States of America. *Am. Psychologist*, **12**, 740-46 (1957)
119. Mengelkoch, R. F., Adams, J. A., and Gainer, C. A. *The Forgetting of Instrument Flying Skills as a Function of the Level of Initial Proficiency*. U. S. Navy, NAVTRADEVEN TR 71-16-18 (Port Washington, N. Y., 1959)
120. Mengelkoch, R. F., and Houston, R. C. *Investigations of Vertical Displays of Altitude Information: I. Comparison of a Moving-Tape and Standard Altimeter on a Simulated Flight Task*. AF WADC TR 57-384 (Dayton, Ohio, 1958)
121. Mengelkoch, R. F., and Houston, R. C. *Investigations of Vertical Displays of Altitude Information: II. The Effect of Practice on Performance of a Simulated Flight Task Using a Moving-Tape Altimeter*. AF WADC TR 57-385 (Dayton, Ohio, 1958)
122. Mengelkoch, R. F., and Houston, R. C. *Investigations of Vertical Displays of Altitude Information: III. The Effect of an Expanded Scale on Performance of a Simulated Flight Task Using a Moving-Tape Altimeter*. AF WADC TR 57-549 (Dayton, Ohio, 1957)
123. Nadler, G., and Goldman, J. Operator performance studies: I. One-plane motion learning. *J. Ind. Eng.*, **9**, 187-97 (1958)
124. Nadler, G., and Goldman, J. The unopar. *J. Ind. Eng.*, **9**, 58-65 (1958)
125. Narva, M. A. *Evaluation of Decision Making Performance on Three Pictorial Navigation Displays*. AF WADC TR 58-49 (Dayton, Ohio, 1958)
126. Nicklas, D. R. *A History of Aircraft Cockpit Instrumentation 1903-1946*. AF WADC TR 57-301 (Dayton, Ohio, 1958)
127. Peters, G. A., and Hussman, T. A. Human factors in system reliability. *Human Factors*, **1**, 38-42 (April, 1959)
128. Pollack, I. Information transmission with elementary multi-variate auditory and visual displays. In *Symposium on Air Force Human Engineering, Personnel, and Training Research*, NAS-NRC Publ. 516, 194-200 (Finch, G., and Cameron, F., Eds., Washington, D. C., 216 pp., 1958)
129. Provins, K. A. Sensory factors in the voluntary application of pressure. *Quart. J. Exptl. Psychol.*, **9**, 28-41 (1957)
130. Ritchie, M. L. and Baker, C. A. (Eds.) *Psychological Aspects of Cockpit Design—A Symposium Report*. AF WADC TR 57-117 (Dayton, Ohio, 1957)
131. Roby, T. B., and Lanzetta, J. T. Considerations in the analysis of group tasks. *Psychol. Bull.*, **55**, 88-101 (1958)
132. Rockway, M. R. *Effects of Variations in Control Dead-space and Gain on Tracking Performance*. AF WADC TR 57-326 (Dayton, Ohio, 1957)
133. Rockway, M. R., and Franks, P. E. *Effects of Variations in Control Backlash and Gain on Tracking Performance*. AF WADC TR 58-553 (Dayton, Ohio, 1959)
134. Ross, S., Dardano, J., and Hackman, R. C. Conductance levels during vigilance task performance. *J. Appl. Psychol.*, **43**, 65-69 (1959)

135. Rund, P. A., Birmingham, H. P., Tipton, C. L., and Garvey, W. D. *The Utility of Quickening Techniques in Improving Tracking Performance with a Binary Display*. U. S. Navy, NRL Rept. 5013 (Washington, D. C., 1957)
136. Sabeh, R., Jorve, W. R., and Vanderplas, J. M. *Shape Coding of Aircraft Instrument Zone Markings*. AF WADC TR 57-260 (Dayton, Ohio, 1957)
137. Schipper, L. M., Kidd, J. S., Shelly, M. W., and Smode, A. F. *Terminal System Effectiveness as a Function of the Method Used by Controllers to Obtain Altitude Information: A Study in Human Engineering Aspects of Radar Air Traffic Control*. AF WADC TR 57-278 (Dayton, Ohio, 1958)
138. Seckel, E., Hall, I. A. M., McRuer, D. T., and Weir, D. H. *Human Pilot Dynamic Response in Flight and Simulator*. AF WADC TR 57-520 (Dayton, Ohio, 1958)
139. Siegel, A. I., and Stirner, F. W. *Caution and Warning Light Indicators for Naval Aircraft: VII. The Effects of Color Contrast, Brightness Contrast, and Mode of Legend Presentation on the Attention Intruding Value of Peripherally Positioned Light Indicators*. U. S. Navy, NAMC-ACEL-369 (Philadelphia, Pa., 1958)
140. Simon, C. W. (Ed.) *Human Factors Society Bulletin* (Human Factors Society, Santa Monica, Calif.)
141. Smith, B. J. (Ed.) *Human Control Dynamics in Air and Space Craft* (Flight Safety Foundation, Inc., New York, N. Y., 42 pp., 1959)
142. Smode, A. F. Learning and performance in a tracking task under two levels of achievement information feedback. *J. Exptl. Psychol.*, **56**, 297-304 (1958)
143. Soar, R. S. Numeral form as a variable in numeral visibility. *J. Appl. Psychol.*, **42**, 158-62 (1958)
144. Squires, P. C. *New Digit Designs for Use under Reflected Red Light of Low Brightness*. U. S. Navy, MRL Rept. 284 (New London, Conn., 1957)
145. Stirner, F. W., Siegel, A. I., and Baker, R. C. *Caution and Warning Light Indicators for Naval Aircraft: VI. An Experimental Comparison of Visual, Auditory and Visual-Auditory "Master" Signals*. U. S. Navy, NAMC-ACEL-357 (Philadelphia, Pa., 1957)
146. Svimonoff, C. *The Air Force Integrated Flight Instrument Panel*. AF WADC TR 58-431 (Dayton, Ohio, 1958)
147. Sweeney, J. S., Bailey, A. W., and Dowd, J. F. *Comparative Evaluation of Three Approaches to Helicopter Instrumentation for Hovering Flight*. U. S. Navy, NRL Rept. 4954 (Washington, D. C., 1957)
148. System Development Corporation. *1959 National Salary Survey of Human Factors Professional Personnel* (System Development Corporation, Santa Monica, Calif., 1959)²
149. Tanner, W. P., Jr., and Swets, J. A. A decision-making theory of visual detection. *Psychol. Rev.* **61**, 401-9 (1954)
150. Taylor, F. V., and Garvey, W. D. The limitations of a "procrustean" approach to the optimization of man-machine systems. *Ergonomics*, **2**, 187-94 (1959)
151. Torre, J. P., and Sanders, L. A. *An Investigation of Symbol Meaning Combinations for Use in Radar Displays*. U. S. Army, Tech. Memo 1-58 (Aberdeen, Md., 1958)

² Available only to participating organizations.

152. Warren, N. D. Educational programs in the human factors area. *Human Factors*, 1, 12-15 (April, 1959)
153. White, W. J. *Acceleration and Vision*. AF WADC TR 58-333 (Dayton, Ohio, 1958)
154. White, W. J., and Riley, M. B. *The Effects of Positive Acceleration on the Relation between Illumination and Instrument Reading*. AF WADC TR 58-332 (Dayton, Ohio, 1958)
155. Williams, A. C., Jr., and Hopkins, C. O. *Aspects of Pilot Decision Making*. AF WADC TR 58-522 (Dayton, Ohio, 1958)
156. Wright, N. L., and Seminara, J. L. *Readability Thresholds of Letters and Numerals Backlighted by Radioactive Illuminants*. U. S. Army, TR 24711 (Dover, N. J., 1958)
157. Wulfeck, J. W., Weisz, A., and Raben, M. W. *Vision in Military Aviation*. AF WADC TR 58-399 (Dayton, Ohio, 1958)
158. Xhignesse, L. V. *Selective Survey of French Developments in Flight Simulators and Flight Instruments: I. Flight Simulators*. AF WADC TN 57-378 (Dayton, Ohio, 1957)

COLOR VISION^{1,2,3}

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This review represents our attempt to bring together the recent reports concerned with color vision in such a way as to provide a representative, although necessarily very incomplete, picture of this research area. The material is organized in terms of issues, both those that have now been partially resolved and those that remain wide open, and in terms of the variety of approaches that result from the overlapping interests of psychologists, physicists, ophthalmologists, biochemists, and neurophysiologists. Such an overview cannot be gained from citations of papers published in the last year alone, but, wherever possible, we have cited the most recent reports in a given area, particularly when these reports include the required background information. Since we have sought to focus on trends, isolated reports of value in their own right, but not directly related to the more prominent issues, have necessarily been slighted. Our critical interpretations naturally reflect our own biases, but we have sought also to represent fairly the interpretive convictions of the original investigators whose works are cited.

SPECTRAL SENSITIVITY

The spectral sensitivity of the human eye has been determined hundreds of times since the first measurements of Fraunhofer in 1815. Still, interest and research in this fundamental property of the eye continues unabated, and experimental data were reported in the past decade for a wide variety of conditions by more than a dozen or so investigators. The most recent reports are those of Sperling (198), Bedford & Wyszecki (15), and Dillon & Zeghers (59), in which references to the earlier papers can be found.

Two important generalizations emerge. (a) The newer data agree in showing a higher sensitivity in the short wave spectral region than do the older data, particularly as codified by the CIE standardization. (b) The photopic spectral luminosity function is clearly not a smooth and symmetrical one of a simple Gaussian form. It is, in fact, persistently described as having "inflections," "notches," "shoulders," "hollows," "bumps," "humps," "dips," "depressions," and "secondary maxima." Although agreement is not complete, the inflection points seem generally to be reported as occurring in the spectral regions 440 to 450 $m\mu$, 480 to 490 $m\mu$, 570 to 580 $m\mu$, and 600 to 610 $m\mu$. Clear evidence of these inflections was seen in the early work of Gibson and

¹ The survey of the literature pertaining to this review was completed April 1, 1959.

² In this chapter the following abbreviations will be used: CIE (Commission Internationale d'Eclairage); ERG (Electroretinogram).

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Tyndall and Sloan, but the discontinuities noted then were glossed over, largely under the influence of standardization needs and practices.

Theoretical interest in the luminous efficiency function, as it is often called, stems from the possibility that it may reflect the loci of the maxima of individual photopigment distributions or of "color receptors." Considerable attention has also been given to the possibility that the inflection points in the shorter wavelengths are related to the absorption characteristics of the intervening ocular media, particularly the macula lutea. The weight of the evidence to date suggests that factors other than selective pigment filtering by the macula are also involved (10, 59, 128, 199, 209, 226). The question is still unresolved, however, since some investigators who have found exaggerated shoulders in the retinal periphery where macula lutea is absent have, unfortunately, used yellowish-white adapting fields which are bound to sensitize the short-wave region of the function. A completely satisfactory analysis of the various discontinuities in the luminosity function is yet to be made.

There has been an increasing concern with problems of variability, both intra- and interobserver (188). Crozier (54) hoped to analyze the contributions of individual chromatic processes in terms of threshold variability. He postulated that variability minima occur in spectral regions where the population of potentially excitable elements of sensory effect is small, and vice versa. Weale (224) has offered additional experimental support for the oscillatory type of variability function, although Dillon & Zeghers (59) have failed to reproduce the Crozier results with a different technique. Bedford & Wyszecki (15), who confirm some of the older evidence for a reverse Purkinje shift, also emphasize large interobserver differences and advise against the use of average luminosity data in fundamental studies of visual processes.

Data from both Galifret & Piéron (83) and Sperling (198) once again show that systematically different results are obtained with different techniques, e.g., flicker and equality of brightness matches. We believe that this unresolved empirical issue requires further work on the temporal aspects of the problem of the sort pursued earlier by Ferree and Rand. Since different techniques of measurement are known to give different results, it would seem advisable to refrain, meanwhile, from following Wright's procedure of using different techniques for different parts of the spectrum in constructing a single spectral luminosity function (119, 239). Whatever the index measure used, a fundamental question still remains. What is the relation of the spectral luminosity function, defined in terms of the reciprocal of the energy necessary to evoke a sensation of equal brightness, to the relative brightness of an equal energy spectrum?

COLORIMETRIC SPECIFICATION

Although the primary *raison d'être* of the CIE coordinate system of colorimetric specification is to serve the needs of business and industry (134), the system is based on a mathematically convenient transformation of experimentally determined spectral color-mixture and photopic luminosity data,

and, hence, provides the researcher with a valuable average standard for these characteristics of normal color vision. Accumulated evidence of certain rather serious inaccuracies in both the standard luminosity function and the colorimetric specifications has prompted the undertaking of an experimental redetermination of the basic data. Stiles (202) and Stiles & Burch (204) have recently reported completed color-mixture and luminosity functions for 50 subjects for a 10° field, a formidable accomplishment that followed a pilot study in which results were obtained for 10 individuals for both a 10° and a 2° field. Data for a smaller number of subjects have also been reported by Bongard, Smirnov & Friedrich (22), Friedrich (77), Speranskaya (197), Ishak (119, 120, 121), and Sperling (198).

An important basic problem brought into focus by the re-evaluation of the colorimetric standard concerns the question of whether or not luminances are really additive—an assumption fundamental to photometry and colorimetry, but recently brought into serious question in a number of experimental reports (47, 65, 69, 83, 148, 208, 216, 217, 230). Part of this difficulty may be related to the differences in luminosity functions measured by different techniques, and certainly the departures from additivity are greatest for heterochromatic brightness matches (198). The practical resolution to this problem seems to be to use, for the revised tristimulus curves, the luminosity data that most closely fulfill the additivity assumption, under which circumstances the systematic errors do not exceed the interobserver variability (198, 202, 240). This resolution does not, of course, solve the theoretical issue of additivity, and experimental exploration of the problem will probably continue.

There are additional sources of uncertainty of relevance for those interested in the new colorimetric data as norms for research purposes rather than as industrial standards. The nonhomogeneities between center and periphery of large, centrally-fixated stimulus fields preclude exact color matches (especially in the short-wave spectral region) for the 10° area as a whole. Equations are consequently made either by ignoring the center of the field, as in the Stiles experiments, or by masking out the central 2° area, as in the Speranskaya measurements. Moreover, Stiles reports that, contrary to the strict requirements of colorimetric theory, 10° color-match data obtained for one set of stimulus primaries must be corrected for a specific amount of what he calls "rod intrusion" in order to be compatible with matches made by the same individuals using different wavelengths for the matching primaries. Actual "field trials" of the proposed new standard will presumably provide the necessary verification of the functions before their adoption for practical colorimetry (39, 135, 141), and the difficulties cited above will probably be of significance only for the more exacting demands of the research laboratory.

Attempts continue to be made to provide transformations of the CIE space to a visually uniform co-ordinate system that would provide a measure of perceived color differences—a purpose for which the system was not originally intended. The degree to which such transformations approximate this goal is usually evaluated, as in Burnham's early study (38), relative to the

Munsell standard samples, whose notations are based on visually uniform steps of hue, chroma (saturation), and value (lightness). Although some of these transformations have a theoretical basis (58, 86, 116, 152, 192), others are derived from empirical determinations of least discriminable color differences in various regions of the CIE space (37, 147, 149, 174, 178). As Judd has pointed out (134), it is unlikely that a single transformation will provide the kind of perceptually uniform spacing sought unless provision is made for taking into account in the mathematical transformations the variations in discrimination that occur with changes in adaptation, luminance level, etc. (36, 96), even though the basic color equations are essentially independent of these variables.

Although the well-known Bezold-Brücke phenomenon makes it obvious that the relation of hue differences to differences in wavelength must vary with the luminance level, recognition of the dependence of wavelength discrimination functions on the luminance parameter has become explicit only in the past decade in the experiments of Weale (225, 226), Thomson & Trezona (213), and, most recently, Bedford & Wyszecki (14). Bedford & Wyszecki also call attention to differences in discrimination functions that may depend on long viewing times as contrasted with the scanning technique used in their experiments.

Surprisingly, the time variable is still frequently ignored in experiments concerned with color vision at suprathreshold levels. Farnsworth, however, has recently made an important contribution by accounting for the discrepancies among sets of color difference and discrimination data in terms of probable differences in observation time (68). Since the discrepancies are restricted to the yellow-blue dimension, Farnsworth suggests that they may reflect different time dependences for the different chromatic systems, a suggestion that is supported by the evidence that similar paired differences also occur in chromatic thresholds and luminance-dependent hue and saturation functions (67, 117).

COLOR ADAPTATION AND COLOR CONTRAST

Since the retinal stimulus varies markedly with changes in illumination, approximations to color constancy are possible only because of compensatory changes in the visual system, and experimental interest in the nature and extent of these changes for various conditions of adaptation is based both on the practical needs for generalized predictions and the obvious importance of these effects for color theory. Helson & Michels (107), Hurvich & Jameson (114, 127), Kellershohn (140), and Yustova (241) have all been concerned with some aspect of the perception of achromaticity (whiteness, grayness) under various conditions of adaptation, and the broad generalization of their findings is that perceptual "whiteness" is evoked by a stimulus that approximates the quality of the adapting illuminant, or, conversely, that any stimulus to which the eye is exposed approaches a neutral appearance in time. Striking examples of this tendency carried to completion are

given in the Ganzfeld study by Hochberg, Triebel & Seaman (109), and in the stabilized image experiments of Riggs *et al.* (184) and of Ditchburn, Fender & Mayne (61). In these special circumstances, prolonged exposure leads eventually to complete disappearance, not only of hue, but of all light sensation.

Earlier disagreement on whether or not the form of the photopic spectral luminosity function is altered by chromatic adaptation seems to have been settled in the affirmative by Hurvich & Jameson (115, 128), Brennen (32), and Auerbach & Wald (10). Whether the measures are based on threshold determinations in the presence of a chromatic surround, thresholds during the early part of the recovery curve, or heterochromatic brightness judgments, the function shows changes in luminosity that are different in different parts of the spectrum, with relative reductions occurring in the spectral regions that are similar in color appearance to the adapting light. The changes are more marked for stronger adapting stimuli (10), but, also, for a fixed adaptation the effects are greater for low levels of test luminance (115), a finding that argues against an exclusively photochemical interpretation. However, the main theoretical import of the spectral luminosity findings is that multiple photoreceptor substances would seem to be involved in the mechanism subsuming achromatic brightness, even though, as Piéron (168) has concluded from earlier work on adaptation, the luminosity or whiteness responses may be mediated by physiological processes that are quite distinct from those mediating hue responses.

Stiles (203) has continued to explore chromatic adaptation effects by measurements of spectral increment-threshold functions, which involve discrimination of differences in hue and saturation as well as of brightness. Stiles' analysis, which assumes that the spectral function represents the envelope of the response curves of separate chromatic mechanisms that are selectively accentuated by the different background adaptations, suggests the activity of at least five component processes. A series of reports by Bush (45), Boynton (29), and Boynton & Kandel (30) describe increment-threshold experiments in which the durations of both pre-exposure and background "masking" stimuli are independently manipulated. The form of the spectral function varies markedly with the background chromaticity when test flashes are superimposed during the "sensation rise" time (0.05 sec. delay) of the background stimulation, but the selective effects are much smaller when the system has previously been desensitized by continued (5 min. or more) pre-exposure stimulation (45). Boynton (29) analyzes the results in terms of four underlying sensitivity functions, and the differential exposure-time dependences are thought to reflect responsiveness determined by ongoing neural events, on the one hand, and photochemically based sensitivity changes, on the other (30). The work of Bouman (25) and Bouman & ten Doesschate (26) on adaptation and contrast thresholds represents another attempt to distinguish the separate roles of photochemical and neural events, in this case by analysis in terms of specific quantal hypotheses.

Brindley (33) has sought to clarify the photochemical events by studying the breakdown of color matches that occurs following exposure to extremely bright chromatic stimuli. He suggests that the effect occurs because one of the cone photochemicals is decomposed by the strong bleaching light, whereas another is unaffected. It is important to note that the adapting intensities with which Brindley is working are well beyond the range encountered in normal photopic viewing conditions, and that such extreme stimulation involves not only highly complex aftereffects, but also induces rapidly alternating color and brightness changes and reversals during the exposure, as recently described by Cornsweet *et al.* (51). The long accepted fact that color equations are independent of chromatic adaptation for normal photopic adapting luminances has received one more confirmation in a report by Gregory (92).

However, by differently adapting either the two halves of the same retina or the two eyes of the same observer, color matching techniques can be used to determine color stimuli that are perceptually equivalent for different states of chromatic adaptation. Experiments of this sort, numerous in recent years, have been reported by Burnham, Evans & Newhall (42, 43), Fry (79, 80), Wassef (223), Hunt (111, 112, 113), Winch & Young (237), Sanders (187), Frieser & Reuther (78), and MacAdam (150, 151). The technique employed by Helson, Judd, and their co-workers (105, 106) involves uniform conditions of chromatic adaptation in separate experimental sessions, with intercomparisons made in terms of subjective scaling judgments that are based on the previously learned Munsell system of color notation.

Mathematical analyses of such data which seek to yield generalized prediction formulas to relate perceptually equivalent stimuli for the different conditions of adapting illumination, or more ambitiously, to determine the unique set of spectral sensitivity functions required to account for the measured adaptation effects, have so far yielded only approximate solutions at best. Moreover, the strict validity of the quantitative generalizations seems to be limited to the data obtained in the individual experiments, as indicated by Nickerson's (162) and Burnham's (40) recent comparisons of a number of such prediction formulas for daylight and tungsten illuminations. Although a number of potential sources of error probably contribute to the difficulties of such analyses, Hurvich & Jameson (118) conclude from their own work that there is inherent in the usual mathematical treatment a major theoretical oversimplification because of the assumption, either explicit or implicit, that photochemically determined receptor sensitivity changes alone can account for the observed data. They believe that the significance of simultaneous and successive color contrast effects, which are not dependent on long pre-exposures and selective photochemical bleaching, can and should be taken into account, both in the design of such color adaptation experiments and in the data analysis.

The demonstrations by Land (143) of "full color" photographic projections, using additive mixtures of only two chromatic sources or of one chromatic illuminant plus white, that have aroused so much public attention are

neither more nor less than stunning illustrations of simultaneous induction or contrast mechanisms. Although usually demonstrated in simpler stimulus configurations, the effects themselves have long been known. Plateau (169) in 1878 summarized the earlier history of the observation of these effects, back at least as far as Leonardo da Vinci, in his bibliographical memoirs on color contrast and colored shadows, and they have long served as a bone of contention between theorists who lean toward the Helmholtzian interpretation based on "unconscious inference" on the one hand, and those who follow Hering and Mach in looking to a physiological mechanism of opponent interaction, on the other. Land's current rediscovery and dramatic exploitation of color contrast effects (even though he does not recognize their nature, history, and place in color theory) do serve to underscore the need for their inclusion in any analysis of changing color perceptions under different viewing conditions.

A quite different order of intriguing perceptual effects that require weeks or even months to develop are those reported by Kohler (142), who describes the wearing of spectacle lenses that are differently colored on the left and right sides so that the color of the image seen by the central part of each retina varies with direction of regard. After many days, the initially obvious color differences are no longer apparent, and, when the colored lenses are finally removed, long-enduring complementary colored aftereffects are observed which seem to be related, again, to direction of regard. These reports imply fundamental changes in the dynamic organization of the sensory and oculomotor pathways, and it would be valuable to have Kohler's "ground-breaking" experiments in this area repeated with more systematic and extensive measures of specific color functions, both during and after the adaptation period.

SMALL-FIELD TRITANOPIA

Whether or not the central fovea is blue-blind (tritanopic) is a question that has stirred considerable experimental activity in recent years, but one that is now largely clarified. The question has obvious theoretical implications related to the retinal distribution of rods and cones, and was argued by König and Hering many years ago. Reawakened interest stemmed from Willmer's (232) rediscovery of the phenomenon and his highly speculative theoretical views based on the idea that the normal rod-free fovea is dichromatic, rather than trichromatic, and that the dichromat is totally color blind in the central fovea.

Experimental data bearing on the issue of "foveal tritanopia" have been collected by many investigators. Reports have appeared by Willmer & Wright (236), Hartridge (99), Thomson & Wright (214), Middleton & Holmes (156), Gilbert (85), Brown (35), Weale (225), Middleton & Mayo (157), Burnham & Newhall (44), Thomson (211), Galifret & Piéron (82), Farnsworth (67), Cruz & Moreland (55), and Hurvich & Jameson (118). The cumulative evidence has made it clear that the effect is not one restricted to

blueness alone, but that when it does occur yellow losses are linked with blue ones. Furthermore, these losses are now known to depend upon low intensity as well as small field size and not to be restricted to the central fovea. It is, as Hartridge's and Farnsworth's work shows, a threshold phenomenon in which area and luminance play reciprocal roles.

Theoretical postulates which seek to explain the effect as due to loss or reduction of blue receptor activity or excitability fail to cope with the facts of the yellow-blue linkage. On the other hand, theoretical positions which postulate that the relative magnitudes of red and green as compared with yellow and blue activities are differently dependent on luminance and area can be shown to square directly with the experimental results. Specific differences in the manifestation of the effect between the fovea and extrafoveal areas have been related to differences in the distribution of the macular pigment in the retina (118), although better histological evidence on the distribution of macular pigment within the area of central fixation is needed for final resolution of this problem.

COLOR BLINDNESS

Color blindness has always had an inherent fascination all its own and interest in it has continued high. Rare forms of color blindness, tests, distribution and frequency of defects, theoretical interpretations, and genetic questions continue to be explored and debated and the end is nowhere in sight.

Weale's work (227) on three atypical color-blinds, or cone-monochromats as he calls them (with normal visual acuity), showed them to have a photopic luminosity function substantially like that of normals. He viewed this as "hardly compatible with the trichromatic theory which postulates that spectral sensitivity is the sum of the three colour-mediating mechanisms." It is, in fact, a further bit of evidence for a separate luminosity mechanism that is independent of the color mediating responses. Baumgardt (12), who reinvestigated one of Weale's cone-monochromats, is, however, reluctant to interpret the case as one of cone activity exclusively.

Sloan's investigations (193, 194) of typical achromatopsias of the sort characterized by low visual acuity, photophobia, nystagmus, and scotopic visibility functions have kept an important issue before us. Although this condition is usually regarded as evidence for exclusively rod retinas, Sloan accepts the breaks she finds in the dark-adaptation functions of these individuals as *prima-facie* evidence that photopic, as well as scotopic, receptors are present. Whether the former are interpreted as "photopic rods" or as what Sloan calls "cones which lack hue discrimination," the traditional scotopic-photopic, rod-cone duplicity distinction is certainly blurred by these findings as well as by those of Elenius & Zewi (66) and Rendahl (177), who found photopic ERG potentials in some typical achromats. Baumgardt & Magis' (13) case of "typical achromatopsia" is especially instructive. From breaks in dark-adaptation curves comparable to Sloan's, Baumgardt & Magis draw

the more challenging conclusion: either the interpretation of typical achromatopsia as involving only rods is erroneous or the now classical rod-cone duplicity interpretation of the normal dark-adaptation curve is erroneous. However, a still more interesting finding in this case is the fact that the subject was discovered to have chromatic perceptions essentially like those of a protanope if the test field size was sufficiently large or the luminance sufficiently high. This finding, of course, invalidates the authors' conclusions with respect to true achromatopsia, but it also suggests that a wide range of stimulus variables should always be used in checking apparent cases of total color blindness (123) or, for that matter, dichromats (126).

In one of their characteristically satiric critiques, Walls & Heath (220) sought to dispose of "photopic rods," which look more like cones and may even be "nonfunctioning cones." Assuming that all the monochromats' cones are exclusively of a type mediating the blueness sensation in normal color vision, the authors believe that these cases are essentially "double loss" systems. Although we sympathize with Walls & Heath's effort to seek a coherent explanation for the entire syndrome—color blindness, photophobia, nystagmus, etc.—one's confidence is shaken by their selection of data to argue their ingeniously reasoned case. The complexities are far from unraveled, however, and will probably remain so as long as the importance and extent of macular dystrophies in these cases are not fully explored and as long as free-wheeling speculation continues to be the order of the day.

The literature on tritanopia (125)—a form of yellow-blue blindness—has been enriched by two reports of individual cases (70, 136) and by Wright's (239) location of 17 confirmable cases achieved by his resourceful use of Farnsworth's tritanopic plate in a widely circulated illustrated magazine as a mass public-screening device. Seven of these were subjected to precise testing, and quantitative data on luminosity, color mixture functions, and wavelength discrimination were obtained. The spectral sensitivity of tritanopes differs little from that of normals, showing only slight reduction in the short wave region. Nevertheless, Thomson & Wright (215) interpret this condition in traditional fashion as due to "blue receptor" loss and, on the basis of all the various measures for the tritanope, compute the form of the normal's presumptive "blue" spectral sensitivity function.

Differential color vision in the two eyes of a single individual turned up in two instances. Both Sloan & Wollach's (196) and Graham & Hsia's (90) unocular deuteranopes confirm once again that color losses in the deuteranopic eye are paired and that the remaining perceptions are restricted to yellow-blue and white-black dimensions. The color mixture data, luminosity, and wavelength discrimination functions presented by Graham & Hsia for both eyes of their subject raise a number of questions. The finite, measurable wavelength discrimination of the defective eye in the long-wave spectral region beyond 550 $m\mu$ conflicts with most older data in the literature and, also, with a recent report by Kato & Tabata (139). More disturbing still, the discrimination and color mixture data measured for this same eye are mu-

tually contradictory, since the latter indicate that the spectrum is undifferentiable from 520 to 700 m μ . The color-blind eye of this observer also shows a depression of the luminosity function in the middle- and short-wave regions as compared with the normal eye, and this loss is shown to be a supra-threshold as well as threshold one (17, 18).

Depressed spectral sensitivity in the blue-green portion of the spectrum relative to that of the normal is reported for five additional deuteranopes by Graham and Hsia [Graham (89)] and has also been found by Zanen, Wibail & Meunier (243). This finding supports the earlier results of Hecht (102) and is now being pressed vigorously by Graham and Hsia. However, Graham and Hsia, themselves, report that one of their deuteranopes is not different from normal, and Heath's flicker data (101) do not show short-wave losses but rather sensitivity increases in the long-wave region. There are methodological differences, but, in view of the high interobserver variability both among normals and deuteranopes (70, 84, 164, 198, 209, 222, 234), the problem may reduce simply to one of sampling. Moreover, the role of selective macular pigmentation in reducing sensitivity in the low and middle wavelength regions needs to be evaluated (24, 136).

As for interpretation, all possible combinations of the classical views of protanopia and deuteranopia have been restated in recent reports. Nuberg & Yustova (163) reaffirm the classical interpretation of both protanopia and deuteranopia as simple loss systems; Walls & Mathews (222) regard them as loss and collapse systems, respectively; Graham & Hsia (90) consider both types to be complex collapse forms; and Rushton (185), while accepting simple loss for protanopes, proposes that deuteranopes lose one class of cone but combine two different pigments in a remaining class—both loss and fusion for the deuteranope!

The problem of whether protans and deutans are distinct classes, as is commonly believed, or whether they are variants of one single class has been approached by using spectral threshold measurements at a single wavelength (46) (which unfortunately does not distinguish between absolute and relative sensitivity losses), by measuring acuity with different colored backgrounds (75), and in terms of neutral point determinations. Walls & Heath's (221) evidence on the latter indicates a sharp dichotomy, but whether or not they have determined true spectral neutral points is still debatable since the validity of their method of extrapolation to the spectral locus depends on their choice of "white" stimulus (127, 221). Direct experiment with spectral lights, under controlled conditions to eliminate adaptive and induction effects, will alone serve to check the true spectral loci of the dichromat's neutral points.

Walls & Mathews (222) have argued that the entoptic projection of Maxwell's spot is due, not to the yellow macular pigment, but rather to receptor distribution patterns. Their assertion that deuteranopes cannot see the Maxwell spot came in with a bang in their polemical account of color blindness and the means of diagnosing it (222). The claim that the pattern

is absent in deuteranopes has now gone out with a scarcely noticeable whisper in a footnote to the article by Walls & Heath (221) cited above. As Murray (161) had anticipated, deuteranopes can indeed see the Maxwell spot by using a slightly bluer viewing light along with Walls' purple filter. Much of Walls' theoretical superstructure will now require re-examination.

New developments in color-vision testing are color-aptitude (60) and color-memory (41) tests for normals. These have been designed primarily for occupational selection purposes. For testing color defects, pseudoisochromatic tests appeared in new editions; new versions and comparative evaluations of them have continued apace (16, 76, 171, 195). Although there is high intertest agreement among these instruments in separating the sheep from the goats, i.e., distinguishing normals from red-green defectives, there is disagreement when it comes to finer diagnostic distinctions. In the absence of any single, completely valid, generally acceptable and readily available standard, test batteries are commonly used for diagnostic purposes. These batteries may include different pseudoisochromatic tests, spectral threshold measures, lantern-light identifications, hue classification, discrimination data (27), and Rayleigh equation color-matching data.

The anomaloscope that is used to measure Rayleigh equations provides the most useful information about color-vision defects short of determining complete color-mixture functions. Willis & Farnsworth's (231) outstanding comparative study of six different instruments shows the spectral line Nagel apparatus to be the most satisfactory. More important still, this study, like the work of Pickford (164), focuses attention on the necessity of obtaining both mid-point and range data in the use of such a color-matching instrument. Although they are somewhat less satisfactory than spectral instruments, a number of newer, less-expensive filter anomaloscopes are reported from several sources (108, 175, 228).

A major shortcoming of the usual anomaloscope measures is their failure to provide information concerning sensitivity along the yellow-blue dimension. There are inherent difficulties due to saturation inequalities for the required matches (179). Pickford (165), who has made an important contribution to the study of color blindness by calling attention to its many complexities, does use a filter anomaloscope to measure systematically both red-green and yellow-blue sensitivities, but his quantitative results are not generally useful. Precise stimulus specifications are lacking; he prefers to report his results in terms of instrument scales only; and the role of macular absorption is slighted. Although most of Pickford's previous theoretical discussions have been in four-variable terms, his most recent publication (166) is noncommittal with respect to alternative theoretical interpretations.

A major theoretical issue basic to much of the above is the relation between the normal, various anomalous, and dichromatic color systems. The usual assumption has been to place anomalous trichromats on a continuum between normal and dichromats. It also has been argued that the continuity exists only between anomalous trichromacy and dichromacy. Still another

view has regarded the anomalous as distinct from both normal and dichromats. Further difficulties in relating the classes arise when luminosity functions are considered, for, although the luminosity functions of protanomalous and protanopic may be similar, their color defects are quite different.

Jameson & Hurvich's theoretical analysis (129) of these problems in terms of the three paired variables of the opponent-colors system has sought to systematize and to bring a measure of coherence to these complexities. By postulating chromatic and achromatic systems that can vary independently in magnitude and spectral form, the necessary additional degrees of freedom are introduced that make it possible to relate the normal, anomalous, and color-blind systems so as to predict quantitatively the color perceptions, luminosity, and discrimination functions of the various groups.

Fry's recent theoretical paper (81) on color blindness assumes four photochemical substances that are chromatically paired. Protanopia and deuteranopia are assumed to result from inoperative red-green mechanisms, but tritanopia is interpreted on the assumption that the normal blue-yellow mechanism functions here as a red-green one. Reflections are also offered on the possibilities of accounting for both luminosity and color-discrimination data for the various forms of color defect, but Fry frankly acknowledges the inherent difficulties faced by his formulation.

The genetic aspects of color blindness seem to be of interest primarily to European investigators with Walls as the outstanding American exception (200). Protanopia and deuteranopia generally continue to be viewed as sex-linked, inherited by means of separate Mendelian recessive mechanisms, and possibly dependent on genes having separate loci on the X-chromosome (170). Yet many findings raise questions about these assumptions (53, 73, 124, 242) and there is much speculation in an attempt to clarify the problems of inheritance of other kinds of color blindness, e.g., tritanopia and the various anomalies (74, 137).

PHOTOCHEMISTRY

Although much is now known about the photochemistry of rod vision and the visual pigment rhodopsin, especially from the work of Wald and his associates in the United States (218) and that of Morton and his colleagues in England [see Collins (50)], information about cone pigments related to the photoreception process for human color vision is still very meager. Out of the multiplicity of visual substances found to occur naturally in lower organisms (52, 160), Dartnall (56, 57) has provided a useful generalization by showing that the spectral absorptions of these substances have a common form and that they differ only in spectral locus. As for specifically photopic cone pigments, Wald and his co-workers have identified chicken, pigeon, and turtle iodopsin, which has maximal absorption at about 560 m μ . They have synthesized a photosensitive material, which they call "cyanopsin," with a maximal absorption at about 620 m μ , but this presumptive cone pigment has not yet been found to occur outside the laboratory.

One of the most promising developments has been the use of reflection densitometry techniques by Weale (229) and by Rushton (186) to measure difference spectra of light reflected from the back of the retina of the intact, living eye before and after selective bleaching. Rushton has reported measurements of the *in situ* bleaching characteristics of rhodopsin in the extrafoveal human retina. For individuals with normal color vision and deuteranopes, he reports two difference spectra with peaks at 540 m μ and 590 m μ , respectively, in the 1.8° foveal area. In the central retinal areas of protanopes and protanomalous individuals, he reports a single difference spectrum that peaks at 540 m μ . Rushton's work holds high promise, although the technique is still not sufficiently sensitive to distinguish more than a single photochemical substance in protanomalous individuals (who are trichromats), nor can it yet be used to measure foveal light absorptions at wavelengths shorter than 500 m μ . Evaluation of the results to date is made difficult by some of the assumptions involved in the measurement procedures. For example, if 700 m μ can be used as a control and measuring light because its reflection from the back of the retina is constant and unaffected by photochemical bleaching, its photochemical absorption is presumably negligible. By what process, then, can it be assumed to excite a light sensation, and how can "deep red" light (of negligible absorption?) be used as a bleaching light to obtain the difference spectrum of a "red-sensitive" pigment?

Although the cone problem is still centered on identification of differently selective photosensitive materials, the current issue for rod photochemistry concerns the discrepancy in magnitude between amount of photochemical bleaching, which is very small, and associated sensitivity changes, which are very large. Wald's recent discussion (218) of this problem cites the many reports suggesting that neural as well as photochemical changes are involved in light- and dark-adaptation and reaffirms his own conviction that the discrepancies in question need not argue against photochemical bleaching and regeneration as the important determinants.

ELECTRORETINOGRAM⁴

A steadily increasing number of research reports concerned with the human ERG have appeared during the last decade, and much attention has been given to the problem of correlating electrical and psychophysical measures of visual response. Although Karpe & Tansley (138) found good agreement between the ERG *b*-wave and visual thresholds during the course of dark-adaptation, a series of studies by Johnson (130) and Johnson & Riggs (132, 183) showed that, although the ERG and psychophysical data both reflect sensitivity changes, the relation between the measures depends on the

⁴ Critical comment on the many papers by Motokawa and his associates dealing with electrical stimulation seems quite unnecessary in view of the fact that Riggs *et al.* (182) and Howarth & Treisman (110) have failed to confirm any of the specific color effects reported.

ERG criterion adopted and does not generally approximate a one-to-one correspondence. A similar situation exists with respect to spectral sensitivity functions. There is some correspondence between *b*-wave and scotopic spectral sensitivity, but the *b*-wave response shows that there is excess electrical sensitivity in the short-wave region of the spectrum (181), a discrepancy most often interpreted as a scattered-light effect (1, 28, 31). Although the ERG pattern is usually dominated by the *b*-wave, considered to reflect rod activity because of its spectral characteristics and its absence in night-blind individuals (8, 189), it is a complex response and new components continue to be revealed in successive studies (7). The details of the electrical response pattern vary with stimulus wavelength, intensity, and state of adaptation (3, 5, 9), and some of the components seem to disappear selectively with different types of visual defect. For example, Bornschein & Goodman (23) show that part of the *a*-wave is deficient or lacking in the totally color blind and night blind; Schubert & Bornschein (189) and Armington (2) report the absence of the long-wave sensitive *x*-wave in protanopes; and Heck & Rendahl (104) found that part of the flicker response is absent in some, but not all, protanopes. Heck & Rendahl's study also showed that the normal flicker response pattern following adaptation to long-wave light is like the protanopic one and that the deuteranopic pattern, which is like the normal for neutral and long-wave adaptations, shows abnormal accentuations following adaptation to mid-spectral light. Concentration on individual components of the ERG, the use of flicker, high adapting luminances, etc., are all designed to establish specifically photopic indices that can be used as a key to the specific retinal mechanisms underlying photopic luminosity and chromatic responses (3, 5, 6, 19, 63, 88, 103, 131). Comparisons of ERG measures of photopic spectral luminosity with psychophysical functions for the fovea are similar to the scotopic comparisons based on the *b*-wave in that they usually show correspondence in the middle- and long-wave spectral regions; but they have excess electrical sensitivity in the short-wave region (3, 5). However, a recent report by Dodt, Copenhauer & Gunkel (62) indicates that the short-wave discrepancy disappears if the ERG function is compared with Wald's measures of photopic luminosity in the 8° extra-foveal region rather than with the foveal measures. Perhaps more important for the issue of correspondence between perceptual and electrical responses to light stimulation are the incidental observations reported by Armington & Biersdorf (6) in a study of chromatic adaptation effects. Under certain conditions in these experiments, large electrical responses were associated with high perceived brightness for long-wave stimulation, but with either no visible effect or a just perceptible flash for short-wave stimuli. In a brief but excellent discussion of the human ERG, Riggs (180) summarizes the complexity of the analytical problem in his statement that "the presence of both photopic and scotopic systems in a retinal structure displaying elaborate spatial and temporal interactions almost guarantees that the electrical responses will be difficult to analyze and interpret."

More detailed information has been gained from animal studies, where the potentiality exists for comparison of the ERG response pattern, not only with behavioral discrimination data (4, 21, 93), but also with photochemical absorptions (87) and with unit neural responses in various retinal and post-retinal structures. Although Brindley (34) concludes in his recent review paper that the ERG response represents the massed electrical activity of the rods and cones, Granit's earlier summary (91) indicated that the relation of the major components of the ERG pattern to specific retinal receptor units is a highly complex one and that it is dependent not only on receptor responses to light stimulation but also on modifications controlled by other neural layers of the retina, and even, as also reported recently by Jacobson & Gestring (122), by centrifugal influences from the optic nerve and higher centers.

A novel technique employed to tease information about separate chromatic components out of the ERG is a wavelength shift procedure employed by Forbes and co-workers (71, 72) with the predominantly cone retina of the turtle. They interpret the wavelength-dependent electrical response changes, which are maximal in three different spectral regions, as shifts from one cone mechanism to another. The ERG spectral sensitivity function is a photopic one which peaks at about $645 \text{ m}\mu$ (4, 72), even for the dark-adapted turtle whose behaviorally determined function shows evidence of a scotopic mechanism and peaks at about $525 \text{ m}\mu$ (4). This is the reverse of the usual situation in most animals, including humans, in whom rods predominate and for whom it is difficult to obtain photopic ERG measures.

NEURAL MECHANISMS

The work on identification of photopic "dominators" and color "modulators" by microelectrode recordings from single ganglion cells has been continued primarily by Granit and his co-workers, and has been summarized in a recent review by Donner (64). These modulator findings gave rise to two quite separate problems, one concerned with the relation of the modulator curves to photopigment absorptions, and the other concerned with their significance for color discrimination as measured behaviorally. The first question is this: Should the existence of narrow-band spectral responses from individual units in the frog, pigeon, snake, etc., be taken to imply the existence of different narrow-band photopigments in these species? Or, as Dartnall suggested (56), do the neuroelectrical responses reflect differences between two broad band photopigments whose absorption functions are displaced relative to each other? Since multiple receptor units are known to converge on single ganglion cells, Dartnall's suggestion, which implies an opponent relation between neural events initiated by the receptor units containing the different broad band pigments, is not an implausible interpretation. Although Granit still thought such an interpretation unlikely in his 1955 review (91), Donner's recent paper states that the evidence suggests that the narrowness of the modulator curves is essentially a result of neural interaction.

The second question is: What is the meaning of the color modulators in the cat, an animal that seems to have no color vision (94, 155)? Granit has made it quite clear (91) that, in his view, the existence of a physiological mechanism for color discrimination does not imply that the animal must be able to use the information provided by that mechanism. Granit dismisses the discrepancy as a pseudoproblem. Remberg (176), however, has offered an alternative solution in his proposal that the selective adaptation experiments required to reveal modulator functions in the cat involved lights that are differently effective for scotopic and photopic mechanisms and that the difference curves interpreted as color modulators really represent only rod-cone differences, rather than differently selective cone types.

Further evidence of a controversial nature about physiological color differentiation in the cat visual system concerns wavelength specific latency differences in the visual centers. Lennox & Madsen (146) found such differences in recordings from the visual cortex, whereas Cohn (49) reports that the unit spike activity patterns recorded from the visual centers show considerable variability, but no systematic dependence on wavelength. Obviously, there is need for clarification of both fact and interpretation of the physiological measures, and the cat will probably remain a controversial animal in physiological laboratories for some time to come.

A series of papers directly concerned with the color mediating process in the fish have been published by Svaetichin and co-workers (153, 154, 205, 206). In some fishes, individual microelectrode records of responses from different retinal units show three different patterns: one (type L), electrically negative throughout the spectrum with maximal amplitude at about 574 $m\mu$ and interpreted as a luminosity response; another (R-G), usually negative for short wavelengths and positive for long with a reversal of polarity at about 590 $m\mu$; and a third (Y-B), also usually negative for short and positive for long wavelengths, but with peaks somewhat different from the R-G type. Although Svaetichin (205) originally believed that the records were intracellular cone responses, it was concluded from later studies that the L-type curves were probably recorded from the region of the large synaptic endings of cones and horizontal cells, and that the records showing change in polarity with change in wavelength were from the bipolar layer of the retina (153). The relation of Svaetichin's findings to Hering's opponent-colors theory is obvious, and he discusses his results in this context.

Svaetichin (205) also relates his electrophysiological measures to behavioral studies showing that teleosts can discriminate colors. It should be noted, however, that the different types of electrophysiological response patterns for fish caught at different depths would suggest: that teleosts from deep waters should have only monochromatic or achromatic vision; that some of those from shallow waters which have the L type and only one of the dual-polarity response functions should be dichromatic in color behavior; and that only those, like the *Mugil*, showing the two dual-polarity functions together with the L type, should exhibit trichromatic color vision (154). We

know of no behavioral evidence for such distinct patterns of color vision from one teleost species to another, and this issue certainly needs exploration.

This particular problem is simply another instance of the general need for behavioral studies that can be correlated directly with physiological data in the same animal. The application of modern behavioral techniques, as represented in the work of Blough (20, 21) and Guttman & Kalish (95) in determining sensitivity and discrimination functions in the pigeon, should be extended to more species. Miles' comparative studies (158, 159) of different forms of primates are also valuable, although a word of caution is needed with respect to his interpretation of the squirrel monkey as a protanope, since his measures do not discriminate between protanopic and deuteranopic characteristics.

The recent years have seen a great deal of progress in our knowledge of the general response properties of visual nervous tissue. The old notions that the cones transmit their individual activities in simple fashion through their individual nerve fiber connections, and thus subserve the fine discriminations of day vision, and that the rods are anatomically grouped so as to pool their combined effects in simple summative fashion by convergence on single ganglion cells, thereby accounting for the high brightness sensitivity of night vision, are definitely outmoded oversimplifications (235). The retinal picture that now emerges is one (a) of a complex and intricate interconnecting network, with functional groupings of receptor elements into "receptive fields" that converge on the ganglion cells, the functional "receptive fields" being subject to alteration by changes in the stimulus parameters and the state of adaptation (11), (b) of a complex interplay of mutually antagonistic "on" and "off" responses (191), and (c) of a complex of physiological interactions in the retina that influence not only the pattern of events at the ganglion cell but responses within the receptor unit itself (97, 98, 172, 173). This whole pattern of activity in response to stimulation is, moreover, exhibited against a background of spontaneous activity (191).

Complexity, however, does not imply disorder, and systematic exploration of the various manifestations of retinal inhibition, interaction, and functional organization has yielded evidence of an intricate but delicately balanced system of physiological events, all related in an orderly (if not yet fully explored or understood) manner (173).

COLOR THEORY

At the time of the International Symposium on Color Vision, held approximately a decade ago, the most widely accepted color theory was still the classical three-color view in its simplest form (102, 238), described by Hecht (102) as "Young's notion that there are three receptor systems in the retina (Young, 1807) which may be designated B, G, and R to indicate their essentially qualitative uniqueness in yielding respectively blue, green, and red sensations when brought into action by light. Each receptor system produces only the sensation unique for it . . ." Two main trends have been in evi-

dence since that time. One is the tendency, exemplified so beautifully in Hecht's own work, to state specific theoretical formulations in a precise and quantifiable manner so as to account, not only for the qualitative phenomena of color vision, but also for the many quantitative psychophysical functions available in the visual literature. The second tendency has been to move away from Hecht's view and from the oversimplified Young-Helmholtz formulation which has proved to be inadequate to handle the facts (144, 145, 212). Both trends were already in evidence in Judd's distinguished contribution (133) to this same International Symposium. The first trend was exhibited in his quantitative restatement of various theoretical views, and the second in his quantitative treatment of the different hypothetical stages of the G. E. Müller zone theory. The manner in which the experimental data themselves have forced a change from the classical view can be seen by contrasting Stiles' early and later theoretical interpretations. In the earlier interpretations (201), his increment-threshold functions represent the activities of a red, a green, and a blue process, whereas in his recent increment-threshold analysis (203), he suggests five processes for foveal vision. The relation of these processes to the photochemicals of the retina, on the one hand, and to the sensory qualities, on the other, are now, moreover, being envisaged as considerably more complex.

Although they are aside from the main trends, mention should be made of Ségál's photochemical views (190) and of Shaw's optical theory (191). Ségál's proposal that visual purple in various states and in various retinal layers is the essential photosensitive substance for mediating wavelength selective light responses was concerned with only one aspect of the perceptual mechanism, and, although it seemed both stimulating and provocative when published, it has received no follow-up. Shaw's proposal that selective light reception is based on a single photochemical substance, and that various visual functions are correlated with physicochemical changes in the dye molecule that are specifically related to the wavelength of incident light, is a novel speculation but reminiscent of some of the older mechanical resonator models for photoreception. Whether the correlations that Shaw finds between psychophysical functions and functions relating wavelength and optical properties are only accidental or whether they indicate something more basic about the peripheral mechanisms of photoreception remains to be determined.

Hartridge's polychromatic theory (100) has sought to encompass a wide variety of data, but it has never been stated in rigorous quantitative terms and has been criticized as inconsistent with the three-variable mathematical requirements of color phenomena (210). Most contemporary theorists (89, 118, 133, 203, 219, 238) now agree that, whatever the multiplicities and complexities of the various physiological processes, the visual system should be conceptualized quantitatively as a three-variable mechanism. Fry (80, 81), on the other hand, adheres to a view that stems in some respects from the Hering opponent-colors theory, but differs from it in that Fry believes the

data require postulation of four independent photochemical substances or processes to mediate color perception. Until very recently, Pickford seemed to have been of the same opinion (165), but his most recent paper (166) indicates that his theoretical position is changing. MacAdam's proposal (151) for five or more independent photochemicals to account for his adaptation data was soon abandoned as untenable (152).

As for attempts to solve the problems of color vision by assigning specific functions to the various histological units of the visual system (48, 233), it now seems evident that it will be necessary to understand the dynamic organization of the retina, as revealed in electrophysiological studies, before specific roles can be assigned to the different anatomical units in terms of their structural organization alone. Talbot (207) made a valiant attempt to state a Müller type theory in terms of the structural components of the retinal network. He made a number of valuable proposals. The suggestion of specific inhibitory relations among the various activities converging at the synaptic mechanisms to yield "difference-response" at the bipolar level is, for example, perfectly consistent with the electrophysiological findings of Svaetichin (206) for the fish retina. A less happy choice was Talbot's linkage of the blue response process with rhodopsin to account for the evidence of so-called "blue-blindness" in the rod-free foveal region. In assigning the initiation of "blue" response processes to the rods, Talbot was incorporating one aspect of Willmer's histological hypothesis (233) that envisages (a) the rod to midget bipolar path as the blue mechanism, (b) the cone to midget bipolar path as the red mechanism, and (c) the rod and cone to flat bipolar path as the green mechanism. This hypothesis loses one of its main props when it becomes clear that the presence or absence of blue sensations is a luminance area threshold effect, not at all linked with the supply or lack of rods in the retinal area stimulated.

A systematic quantitative development of the Hering opponent-colors theory has been reported by Hurvich & Jameson in a series of experimental and theoretical reports (117, 118). This theoretical view assumes three pairs of neural response processes whose activities are mutually antagonistic or opponent within each pair, and are correlated with the opponent and paired sensory qualities: yellow-blue, red-green, and white-black. Different thresholds and different intensity vs. response functions for the three paired processes are assumed and are correlated with the paired-hue changes of the Bezold-Brücke phenomenon, the achromatic interval, small field-low intensity color losses, and different saturation and wavelength discrimination functions at different intensities. The initial photoreceptor light absorptions that activate the opponent response processes are assumed to be controlled by three independent photosensitive materials that may be discretely distributed or combined in the individual receptor units. Slight shifts in the absorption spectra of the photosensitive materials are assumed to account for anomalous, or distorted, psychophysical wavelength functions (discrimination data, color equations, etc.), and decrements or losses in the paired

neural response processes are assumed to be related to color weaknesses and dichromatic color vision. Changes in color appearance with changes in adaptation and illumination are assumed to be related both to photochemical bleaching effects and to spatial interaction effects. Mutual interaction among all elements of the visual field, with opponent induced responses as a basic physiological mechanism, is assumed to be directly related to the phenomena of brightness and color contrast, to color constancy, and to many of the vexing problems of color adaptation. No specific physiological mechanisms for the opponent chromatic and achromatic response processes have been postulated in this theoretical development, but some of the electrophysiological evidence for mutually antagonistic neural processes has been suggested as a general physiological correlate for the postulated response properties.

Although the work of Hurvich & Jameson is most explicit in its direct reliance on the Hering opponent-colors theory, other attempts to express some of the phenomena of color vision in quantitative form have also recently shown a tendency to resort to "difference-formulae," which imply opponent relations between the subtracted "activities," whether or not the opponent mechanism is explicitly recognized. Examples of such approaches are found in the recent reports of MacAdam (152), Hunt (113), and Shklover (192). Walls' "branched-pathway" excess-hypothesis (219) also incorporates a difference concept, but in this case does not imply opponent activities. Walls assumes three chromatic processes, all of which feed some activity into an achromatic luminosity pool. An individual process signals hue only when its activities are in excess of one or both of the other processes. The need for a separate achromatic or luminosity mechanism is recognized in Piéron's modification (167) of the Young-Helmholtz view, in which Piéron postulates a separate ganglion cell for luminosity in addition to those ganglion cells presumed to subservise chromatic discrimination.

Some important psychophysical questions remain to be clarified for the further development of formal color theories. If the functions relating response magnitudes to stimulus magnitudes are not linear, but probably logarithmic or power functions, what are the specific forms of these functions for the various chromatic and achromatic responses, and what is the nature of their dependence upon the state of adaptation? To what extent should the phenomena of brightness and color adaptation be conceived in terms of the laws of photochemistry, and to what extent in terms of changes in neural organization and responsiveness? Precisely how do the activities in neighboring visual areas interact, i.e., how do chromatic and brightness induction effects vary with relative stimulus area, location, separation, and other stimulus parameters?

LITERATURE CITED

1. Asher, H. The electroretinogram of the blind spot. *J. Physiol. (London)*, **112**, 40P (1951)
2. Armington, J. C. Component of the human electroretinogram associated with red color vision. *J. Opt. Soc. Am.*, **42**, 393-401 (1952)
3. Armington, J. C. Electrical responses of the light-adapted eye. *J. Opt. Soc. Am.*, **43**, 450-56 (1953)
4. Armington, J. C. Spectral sensitivity of the turtle, pseudomys. *J. Comp. Physiol. Psychol.*, **47**, 1-6 (1954)
5. Armington, J. C. Amplitude of response and relative spectral sensitivity of the human electroretinogram. *J. Opt. Soc. Am.*, **45**, 1058-64 (1955)
6. Armington, J. C., and Biersdorf, W. R. Flicker and color adaptation in the human electroretinogram. *J. Opt. Soc. Am.*, **46**, 393-400 (1956)
7. Armington, J. C., Johnson, E. P., and Riggs, L. A. The scotopic a-wave in the electrical response of the human retina. *J. Physiol. (London)*, **118**, 289-98 (1952)
8. Armington, J. C., and Schwab, G. J. Electroretinogram in nyctalopia. *A.M.A. Arch. Ophthalmol.*, **52**, 725-33 (1954)
9. Armington, J. C., and Thiede, F. C. Selective adaptation of components of the human electroretinogram. *J. Opt. Soc. Am.*, **44**, 779-86 (1954)
10. Auerbach, E., and Wald, G. The participation of different types of cones in human light and dark adaptation. *Am. J. Ophthalmol.*, **39**, 24-40 (1955)
11. Barlow, H. B., Fitzhugh, R., and Kuffler, S. W. Change of organization in the receptive fields of the cat's retina during dark adaptation. *J. Physiol. (London)*, **137**, 338-54 (1957)
12. Baumgardt, E. Un cas d'achromatopsie atypique. *J. physiol. (Paris)*, **47**, 83-87 (1955)
13. Baumgardt, E., and Magis, C. Sur un cas exceptionnel d'achromatopsie. *J. physiol. (Paris)*, **46**, 237-40 (1954)
14. Bedford, R. E., and Wyszecki, G. W. Wavelength discrimination for point sources. *J. Opt. Soc. Am.*, **48**, 129-35 (1958)
15. Bedford, R. E., and Wyszecki, G. W. Luminosity functions for various field sizes and levels of retinal illuminance. *J. Opt. Soc. Am.*, **48**, 406-11 (1958)
16. Belcher, S. J., Greenshields, K. W., and Wright, W. D. Colour vision survey using the Ishihara, Dvorine, Boström and Kugelberg, Boström, and American-Optical Hardy-Rand-Rittler tests. *Brit. J. Ophthalmol.*, **42**, 355-59 (1958)
17. Berger, E., Graham, C. H., and Hsia, Y. Some visual functions of a unilaterally color-blind person. II. Binocular brightness matches in various spectral regions. *J. Opt. Soc. Am.*, **48**, 622-27 (1958)
18. Berger, E., Graham, C. H., and Hsia, Y. Some visual functions of a unilaterally color-blind person. I. Critical fusion frequency in various spectral regions. *J. Opt. Soc. Am.*, **48**, 614-22 (1958)
19. Biersdorf, W. R., and Armington, J. C. Responses of the human eye to sudden changes in the wavelength of stimulation. *J. Opt. Soc. Am.*, **47**, 208-15 (1957)
20. Blough, D. S. Method for tracing dark adaptation in the pigeon. *Science*, **121**, 703-4 (1955)
21. Blough, D. S. Spectral sensitivity in the pigeon. *J. Opt. Soc. Am.*, **47**, 827-33 (1957)

22. Bongard, M. M., Smirnov, M. S., and Friedrich, L. The four-dimensional colour space of the extra-foveal retinal area of the human eye. In *Visual Problems of Colour, I*, 325-30 (Her Majesty's Stationery Office, London, England, 749 pp., 1958)
23. Bornschein, H., and Goodman, G. Studies of the a-wave in the human electroretinogram. *A.M.A. Arch. Ophthalmol.*, **58**, 431-37 (1957)
24. Bouman, M. A. Quanta explanation of vision. *Docum. Ophthalmol.*, **4**, 23-115 (1950)
25. Bouman, M. A. Peripheral contrast threshold for various and different wavelengths for adapting field and test stimulus. *J. Opt. Soc. Am.*, **42**, 820-31 (1952)
26. Bouman, M. A., and ten Doesschate, J. Nervous and photochemical components in visual adaptation. *Ophthalmologica*, **126**, 222-30 (1953)
27. Bouman, M. A., and Walraven, P. L. A study of normal and defective colour vision. In *Visual Problems of Colour, II*, 461-73 (Her Majesty's Stationery Office, London, England, 749 pp., 1958)
28. Boynton, R. M., Stray light and the human electroretinogram. *J. Opt. Soc. Am.*, **43**, 442-49 (1953)
29. Boynton, R. M. Rapid chromatic adaptation and the sensitivity functions of human color vision. *J. Opt. Soc. Am.*, **46**, 172-79 (1956)
30. Boynton, R. M., and Kandel, G. On responses in the human visual system as a function of adaptation level. *J. Opt. Soc. Am.*, **47**, 275-86 (1957)
31. Boynton, R. M., and Riggs, L. A. The effect of stimulus area and intensity upon the human retinal response. *J. Exptl. Psychol.*, **42**, 217-26 (1951)
32. Brenneman, E. J. Dependence of luminance required for constant brightness upon chromaticity and chromatic adaptation. *J. Opt. Soc. Am.*, **48**, 228-32 (1958)
33. Brindley, G. S. The effects on colour vision of adaptation to very bright lights. *J. Physiol. (London)*, **122**, 332-50 (1953)
34. Brindley, G. S. Work on the electroretinogram. In *Visual Problems of Colour, II*, 507-28 (Her Majesty's Stationery Office, London, England, 749 pp., 1958)
35. Brown, W. R. J. The influence of luminance level on visual sensitivity to color differences. *J. Opt. Soc. Am.*, **41**, 684-88 (1951)
36. Brown, W. R. J. The effect of field size and chromatic surroundings on color discrimination. *J. Opt. Soc. Am.*, **42**, 837-44 (1952)
37. Brown, W. R. J. Color discrimination of twelve observers. *J. Opt. Soc. Am.*, **47**, 137-43 (1957)
38. Burnham, R. W. Comparison of color systems with respect to uniform visual spacing. *J. Opt. Soc. Am.*, **39**, 387-92 (1949)
39. Burnham, R. W. Visual selection of color film neutrals. *J. Opt. Soc. Am.*, **48**, 215-44 (1958)
40. Burnham, R. W. Prediction of shifts in color appearance with a change from daylight to tungsten adaptation. *J. Opt. Soc. Am.*, **49**, 254-63 (1959)
41. Burnham, R. W., and Clark, J. R. A test of hue memory. *J. Appl. Psychol.*, **39**, 164-72 (1955)
42. Burnham, R. W., Evans, R. M., and Newhall, S. M. Influences on color perception of adaptation to illumination. *J. Opt. Soc. Am.*, **42**, 597-605 (1952)

43. Burnham, R. W., Evans, R. M., and Newhall, S. M. Prediction of color appearance with different adaptation illuminants. *J. Opt. Soc. Am.*, **47**, 35-42 (1957)
44. Burnham, R. W., and Newhall, S. M. Color perception in small test fields. *J. Opt. Soc. Am.*, **43**, 899-902 (1953)
45. Bush, W. R. Foveal light adaptation as affected by the spectral composition of test and adapting stimuli. *J. Opt. Soc. Am.*, **45**, 1047-57 (1955)
46. Chapanis, A., and Halsey, R. M. Photopic thresholds for red light in an unselected sample of color-deficient individuals. *J. Opt. Soc. Am.*, **42**, 62-63 (1953)
47. Chapanis, A., and Halsey, R. M. Luminance of equally bright colors. *J. Opt. Soc. Am.*, **45**, 1-6 (1955)
48. Clark, W. E. L. The laminar pattern of the lateral geniculate considered in relation to colour vision. *Docum. Ophthalmol.*, **3**, 57-64 (1949)
49. Cohn, R. A contribution to the study of color vision in the cat. *J. Neurophysiol.*, **19**, 416-23 (1956)
50. Collins, F. D. The chemistry of vision. *Biol. Revs. Cambridge Phil. Soc.*, **29**, 453-77 (1954)
51. Cornsweet, T. N., Fowler, H., Rabedeau, R. G., Whalen, R. E., and Williams, D. R. Changes in perceived color of very bright stimuli. *Science*, **128**, 898-99 (1958)
52. Crescitelli, F. The natural history of visual pigments. *Ann. N. Y. Acad. Sci.*, **74**, 230-55 (1958)
53. Crone, R. A. Combined forms of congenital colour defects. *Brit. J. Ophthalmol.*, **40**, 462-71 (1956)
54. Crozier, W. J. On the visibility of radiation at the human fovea. *J. Gen. Physiol.*, **34**, 87-136 (1950)
55. Cruz, A. C., and Moreland, J. D. Small field tritanomaly in peripheral vision. *Farbe*, **4**, 241-45 (1955)
56. Dartnall, H. J. A. The interpretation of spectral sensitivity curves. *Brit. Med. Bull.*, **9**, 24-30 (1953)
57. Dartnall, H. J. A. *The Visual Pigments* (John Wiley & Sons, Inc., New York, N. Y., 216 pp., 1957)
58. De Kleine, E. H. Quantitative evaluation of color perception: an hypothesis. *J. Opt. Soc. Am.*, **48**, 722-25 (1958)
59. Dillon, D. J., and Zeghers, R. T. Quantal determination and statistical evaluation of absolute foveal luminosity thresholds and of threshold variability. *J. Opt. Soc. Am.*, **48**, 877-83 (1958)
60. Dimmick, F. L. Specifications and calibration of the 1953 edition of the Inter-Society Color Council Color Aptitude Test. *J. Opt. Soc. Am.*, **46**, 389-92 (1956)
61. Ditchburn, R. W., Fender, D. H., and Mayne, S. Vision with controlled movements of the retinal image. *J. Physiol. (London)*, **145**, 98-107 (1959)
62. Dodt, E., Copenhauer, R. M., and Gunkel, R. D. Photopisches Dominator und Farbcomponenten im menschlichen Elektroretinogramm. *Arch. ges. Physiol.*, **267**, 497-507 (1958)
63. Dodt, E., and Wirth, A. Differentiation between rods and cones by flicker electroretinography in pigeon and guinea pig. *Acta Physiol. Scand.*, **30**, 80-89 (1953)
64. Donner, K. O. The spectral sensitivity of vertebrate retinal elements. In *Visual*

- Problems of Colour*, II, 539-66 (Her Majesty's Stationery Office, London, England, 749 pp., 1958)
65. Dresler, A. The non-additivity of heterochromatic brightness. *Trans. Illum. Eng. Soc. (London)*, **18**, 141-65 (1953)
 66. Elenius, V., and Zewi, M. Flicker electroretinography in 6 cases of total colour blindness. *Acta Ophthalmol.*, **36**, 19-25 (1958)
 67. Farnsworth, D. Tritanomalous vision as a threshold function. *Farbe*, **4**, 185-97 (1955)
 68. Farnsworth, D. A temporal factor in colour discrimination. In *Visual Problems of Colour*, II, 429-44 (Her Majesty's Stationery Office, London, England, 749 pp., 1958)
 69. Fedorov, N. T., The additivity of spectral heterochromatic luminances in connexion with the revision of standard spectral mixture curves. In *Visual Problems of Colour*, I, 305-16 (Her Majesty's Stationery Office, London, England, 749 pp., 1958)
 70. Fischer, F. P., Bouman, M. A., and ten Doesschate, J. A case of tritanopy. *Docum. Ophthalmol.*, **5/6**, 73-87 (1951)
 71. Forbes, A., Burleigh, S., and Neyland, M. Electrical responses to color shift in frog and turtle retina. *J. Neurophysiol.*, **18**, 517-35 (1955)
 72. Forbes, A., and Deane, H. W. Color discrimination by the turtle retina. *Science*, **125**, 746-47 (1957)
 73. Franceschetti, A., and Klein, D. Two families with parents of different types of red-green blindness. *Acta. Genet. et Statist. Med.*, **7**, 255-59 (1957)
 74. François, J. L'hérédité en ophtalmologie. *Bull. soc. ophthalmol. Belges*, **118**(1), 1-300 (1958)
 75. François, J., and Verriest, G. Relation entre l'éclairement et l'acuité visuelle dans un groupe de sujets normaux et dans différents groupes d'anomalies congénitales de la vision. *Ophthalmologica*, **135**, 133-204 (1958)
 76. Frey, R. G. Welches pseudisochromatischen Tafeln sind für die Praxis am besten geeignet? *Arch. Ophthalmol. Graefe's*, **160**, 301-20 (1958)
 77. Friedrich, L. Bestimmung der Spektralwertkurven normaler Trichromaten durch direkte Messungen nach einer neuen Methode. *Farbe*, **5**, 201-9 (1956)
 78. Frieser, H., and Reuther, R. Zur Frage der Umstimmung. *Farbe*, **4**, 165-67 (1955)
 79. Fry, G. A. Chromatic adaptation and the red and green fundamental stimuli. *Farbe*, **4**, 175-81 (1955)
 80. Fry, G. A. Chromatic adaptation with special reference to the blue-green region of the colour-mixture diagram. In *Visual Problems of Colour*, II, 665-80 (Her Majesty's Stationery Office, London, England, 749 pp., 1958)
 81. Fry, G. A. Dichromatism and the mechanisms subserving color vision. *J. Opt. Soc. Am.*, **48**, 509-12 (1958)
 82. Galifret, Y., and Piéron, H. L'hétérogénéité fovéale au point de vue de la sensibilité chromatique. *Année psychol.*, **54**, 309-21 (1954)
 83. Galifret, Y., and Piéron, H. De l'erreur systématique que comporte la méthode du papillotement en photométrie hétérochrome. *Rev. Opt.*, **36**, 157-70 (1957)
 84. Gibson, K. S., and Tyndall, E. P. T. The visibility of radiant energy. *Sci. Papers, Natl. Bur. Standards (U. S.)*, No. 19, 131-91 (1923/24)

85. Gilbert, M. Colour perception in parafoveal vision. *Proc. Phys. Soc. (London)*, **63[B]**, 83-89 (1950)
86. Glasser, L. G., McKinney, A. H., Reilley, C. D., and Schnelle, P. D. Cube-root color coordinate system. *J. Opt. Soc. Am.*, **48**, 736-40 (1958)
87. Goldsmith, T. H. On the visual system of the bee (*Apis mellifera*). *Ann. N. Y. Acad. Sci.*, **74**, 223-29 (1958)
88. Goodman, G., and Iser, G. Physiologic studies with flicker electroretinography. *Am. J. Ophthalmol.*, **42**, 212-26 (1956)
89. Graham, C. H. Color theory. In *Psychology: A Study of a Science*, I. 145-287 (Koch, S., Ed., McGraw-Hill Book Co., Inc., New York, N. Y., 710 pp., 1959)
90. Graham, C. H., and Hsia, Y. Color defect and color theory. *Science*, **127**, 675-82 (1958)
91. Granit, R. *Receptors and Sensory Perception* (Yale University Press, New Haven, Conn., 369 pp., 1955)
92. Gregory, R. L. Colour anomaly, the Rayleigh equation and selective adaptation. *Nature*, **176**, 172-73 (1955)
93. Gunter, R. The discrimination between lights of different wavelength in the cat. *J. Comp. Physiol. Psychol.*, **47**, 169-72 (1954)
94. Gunter, R. Does the cat have color vision? *Acta Psychol.*, **11**, 115-16 (1955)
95. Guttman, N., and Kalish, H. I. Discriminability and stimulus generalization. *J. Exptl. Psychol.*, **51**, 79-88 (1956)
96. Halsey, R. M., and Chapanis, A. Chromaticity-confusion contours in a complex viewing situation. *J. Opt. Soc. Am.*, **44**, 442-54 (1954)
97. Hartline, H. K., and Ratliff, F. Inhibitory interaction of receptor units in the eye of Limulus. *J. Gen. Physiol.*, **40**, 357-76 (1957)
98. Hartline, H. K., and Ratliff, F. Spatial summation of inhibitory influences in the eye of Limulus, and the mutual interaction of receptor units. *J. Gen. Physiol.*, **41**, 1049-66 (1958)
99. Hartridge, H. The change from trichromatic to dichromatic vision in the human retina. *Nature*, **155**, 657-62 (1945)
100. Hartridge, H. *Recent Advances in the Physiology of Vision* (J. & A. Churchill, Ltd., London, England, 401 pp., 1950)
101. Heath, G. G. Luminosity curves of normal and dichromatic observers. *Science*, **128**, 775-76 (1958)
102. Hecht, S. Brightness, visual acuity and colour blindness. *Docum. Ophthalmol.*, **3**, 289-306 (1949)
103. Heck, J. The flicker electroretinogram of the human eye. *Acta Physiol. Scand.*, **39**, 159-66 (1957)
104. Heck, J., and Rendahl, I. Components of the human electroretinogram. An analysis in normal eyes and in color blindness. *Acta Physiol. Scand.*, **39**, 167-75 (1957)
105. Helson, H., Judd, D. B., and Warren, M. H. Object-color changes from daylight to incandescent filament illumination. *Illum. Eng.*, **47**, 221-33 (1952)
106. Helson, H., Judd, D. B., and Wilson, M. Color rendition with fluorescent sources of illumination. *Illum. Eng.*, **51**, 329-46 (1956)
107. Helson, H., and Michels, W. C. The effect of chromatic adaptation on achromaticity. *J. Opt. Soc. Am.*, **38**, 1025-32 (1948)

108. Hioki, R., and Nakamura, Y. L'anomaloscope à polarisation de Hioki. *Arch. ophthalmol. (Paris)*, **15**, 258-62 (1955)
109. Hochberg, J. E., Triebel, W., and Seaman, G. Color adaptation under conditions of homogeneous visual stimulation (Ganzfeld). *J. Exptl. Psychol.*, **41**, 153-59 (1951)
110. Howarth, C. I., and Treisman, M. Validity of Motokawa's technique for investigating retinal function. *Nature*, **191**, 834-44 (1958)
111. Hunt, R. W. G. Light and dark adaptation and the perception of color. *J. Opt. Soc. Am.*, **42**, 190-99 (1952)
112. Hunt, R. W. G. Perception of color in 1° fields for different states of adaptation. *J. Opt. Soc. Am.*, **43**, 479-84 (1953)
113. Hunt, R. W. G. Adaptation and the trichromatic theory. In *Visual Problems of Colour*, **II**, 639-64 (Her Majesty's Stationery Office, London, England, 749 pp., 1958)
114. Hurvich, L. M., and Jameson, D. A Psychophysical study of white. III. Adaptation as variant. *J. Opt. Soc. Am.*, **41**, 787-801 (1951)
115. Hurvich, L. M., and Jameson, D. Spectral sensitivity of the fovea. III. Heterochromatic brightness and chromatic adaptation. *J. Opt. Soc. Am.*, **44**, 213-22 (1954)
116. Hurvich, L. M., and Jameson, D. Some quantitative aspects of an opponent-colors theory. IV. A psychological color specification system. *J. Opt. Soc. Am.*, **46**, 416-21 (1956)
117. Hurvich, L. M., and Jameson, D. An opponent-process theory of color vision. *Psychol. Rev.*, **64**, 384-404 (1957)
118. Hurvich, L. M., and Jameson, D. Further development of a quantified opponent-colours theory. In *Visual Problems of Colour*, **II**, 691-723 (Her Majesty's Stationery Office, London, England, 749 pp., 1958)
119. Ishak, I. G. H. The photopic luminosity curve for a group of fifteen Egyptian trichromats. *J. Opt. Soc. Am.*, **42**, 529-34 (1952)
120. Ishak, I. G. H. The spectral chromaticity coordinates for one British and eight Egyptian trichromats. *J. Opt. Soc. Am.*, **42**, 534-39 (1952)
121. Ishak, I. G. H. Determination of the tristimulus values of the spectrum for eight Egyptian observers and one British observer. *J. Opt. Soc. Am.*, **42**, 844-49 (1952)
122. Jacobson, J. H., and Gestring, G. F. Centrifugal influence on the electroretinogram. *Ann. N. Y. Acad. Sci.*, **74**, 362-71 (1958)
123. Jaeger, W. Angeborene totale Farbenblindheit mit resten von Farbempfindung. *Klin. Monatsbl. Augenheilk.*, **118**, 282-88 (1951)
124. Jaeger, W. Werden die angeborenen Störungen des Rotgrünsinns ausnahmslos recessive—geschlechtsgebunden vererbt? *Arch. Ophthalmol. Graefe's*, **152**, 379-84 (1952)
125. Jaeger, W. Tritofornen angeborener und erworbener Farbensinnstörungen. *Farbe*, **4**, 197-216 (1955)
126. Jaeger, W., and Korker, K. Über das Verhalten der Protanopen und Deutanopen bei grossen Reizflächen. *Klin. Monatsbl. Augenheilk.*, **121**, 445-49 (1952)
127. Jameson, D., and Hurvich, L. M. Use of spectral hue-invariant loci for the specification of white stimuli. *J. Exptl. Psychol.*, **41**, 455-63 (1951)

128. Jameson, D., and Hurvich, L. M. Spectral sensitivity of the fovea. II. Dependence on chromatic adaptation. *J. Opt. Soc. Am.*, **43**, 552-59 (1953)
129. Jameson, D., and Hurvich, L. M. Theoretical analysis of anomalous trichromatic color vision. *J. Opt. Soc. Am.*, **46**, 1075-89 (1956)
130. Johnson, E. P. The electrical response of the human retina during dark-adaptation. *J. Exptl. Psychol.*, **39**, 597-609 (1949)
131. Johnson, E. P., and Cornsweet, T. N. Electroretinal photopic sensitivity curves. *Nature*, **174**, 614-15 (1954)
132. Johnson, E. P., and Riggs, L. A. Electroretinal and psychophysical dark adaptation curves. *J. Exptl. Psychol.*, **41**, 137-47 (1951)
133. Judd, D. B. Current views on colour blindness. *Docum. Ophthalmol.*, **3**, 251-88 (1949)
134. Judd, D. B. *Color in Business, Science and Industry* (John Wiley & Sons, Inc., New York, N. Y., 401 pp., 1952)
135. Judd, D. B. Colour mixture functions: progress of field trials. In *Visual Problems of Colour*, **I**, 339-41 (Her Majesty's Stationery Office, London, England, 749 pp., 1958)
136. Judd, D. B., Plaza, L., and Farnsworth, D. Tritanopia with abnormally heavy ocular pigmentation. *J. Opt. Soc. Am.*, **40**, 833-41 (1950)
137. Kalmus, H. The familial distribution of congenital tritanopia with some remarks on some similar conditions. *Ann. Human Genet.*, **20**, 39-56 (1955)
138. Karpe, G., and Tansley, K. The relationship between the change in the electroretinogram and the subjective dark-adaptation curve. *J. Physiol. (London)*, **107**, 272-79 (1948)
139. Kato, K., and Tabata, S. The hue discrimination of normal and color defective subjects. *Acta Soc. Ophthalmol. (Japan)*, **61**, 1647-55 (1957)
140. Kellershohn, C. Adaptation chromatique et lumière blanche. *Farbe*, **4**, 159-64 (1955)
141. Kelly, K. L. Observer differences in colour-mixture functions studied by means of a pair of metameric grays. In *Visual Problems of Colour*, **I**, 343-61 (Her Majesty's Stationery Office, London, England, 749 pp., 1958)
142. Kohler, I. Die Methode des Brillenversuchs in der Wahrnehmungspsychologie mit Bemerkungen zur Lehre von der Adaptation. *Z. Exptl. u. Angew. Psychol.*, **3**, 381-417 (1956)
143. Land, E. H. Color vision and the natural image. Part I. *Proc. Natl. Acad. Sci., U.S.*, **45**, 115-29 (1959)
144. LeGrand, Y. Colour theories and their implications in colour vision. In *Visual Problems of Colour*, **II**, 569-75 (Her Majesty's Stationery Office, London, England, 749 pp., 1958)
145. LeGrand, Y. About theories of color vision. *Proc. Natl. Acad. Sci. U.S.*, **45**, 89-96 (1959)
146. Lennox, M. A., and Madsen, A. Cortical and retinal responses to colored light flash in anesthetized cat. *J. Neurophysiol.*, **18**, 412-24 (1955)
147. Lowry, E. M., and DePalma, J. J. Quantitative relation between chromaticity differences and luminance differences. *J. Opt. Soc. Am.*, **48**, 820-27 (1958)
148. MacAdam, D. L. Loci of constant hue and brightness determined with various surrounding colors. *J. Opt. Soc. Am.*, **40**, 589-95 (1950)

149. MacAdam, D. L. Rautian on color discrimination. *J. Opt. Soc. Am.*, **45**, 1065-71 (1955)
150. MacAdam, D. L. Influence of chromatic adaptation on color discrimination and color perception. *Farbe*, **4**, 133-46 (1955)
151. MacAdam, D. L. Chromatic adaptation. *J. Opt. Soc. Am.*, **46**, 500-13 (1956)
152. MacAdam, D. L. Beat-frequency hypothesis of colour perception. In *Visual Problems of Colour*, **II**, 577-601 (Her Majesty's Stationery Office, London, England, 749 pp., 1958)
153. MacNichol, E. F., Jr., MacPherson, L., and Svaetichin, G. Studies on spectral response curves from the fish retina. In *Visual Problems of Colour*, **II**, 529-38 (Her Majesty's Stationery Office, London, England, 749 pp., 1958)
154. MacNichol, E. F., Jr., and Svaetichin, G. Electrical responses from the isolated retinas of fishes. *Am. J. Ophthalmol.*, **46**, 26-46 (1958)
155. Meyer, D. R., Miles, R. C., and Ratoosh, P. Absence of color vision in cat. *J. Neurophysiol.*, **17**, 289-94 (1954)
156. Middleton, W. E. K., and Holmes, M. C. The apparent colors of surfaces of small subtense—a preliminary report. *J. Opt. Soc. Am.*, **39**, 582-92 (1949)
157. Middleton, W. E. K., and Mayo, E. G. The appearance of colors in twilight. *J. Opt. Soc. Am.*, **42**, 116-21 (1952)
158. Miles, R. C. Color vision in the squirrel monkey. *J. Comp. Physiol. Psychol.*, **51**, 328-31 (1958)
159. Miles, R. C. Color vision in the marmoset. *J. Comp. Physiol. Psychol.*, **51**, 152-54 (1958)
160. Morton, R. A., and Pitt, G. A. J. The multiplicity of visual pigments. In *Visual Problems of Colour*, **I**, 107-20 (Her Majesty's Stationery Office, London, England, 749 pp., 1958)
161. Murray, E. Book review: G. L. Walls, and R. W. Mathews' *New Means of Studying Color Blindness and Normal Foveal Color Vision*. *Am. J. Psychol.*, **67**, 182-88 (1954)
162. Nickerson, D. Measurement and specification of color rendition properties of light sources. *Illum. Eng.*, **53**, 77-86 (1958)
163. Nuberg, N. D., and Yustova, E. N. Researches on dichromatic vision and the spectral sensitivity of the receptors of trichromats. In *Visual Problems of Colour*, **II**, 475-86 (Her Majesty's Stationery Office, London, England, 749 pp., 1958)
164. Pickford, R. W. *Individual Differences in Colour Vision* (George Routledge & Kegan Paul, Ltd., London, England, 386 pp., 1951)
165. Pickford, R. W. A practical anomaloscope for testing colour vision and colour blindness. *Brit. J. Physiol. Optics*, **14**, 2-26 (1957)
166. Pickford, R. W. A review of some problems of colour vision and colour blindness. *Advancement of Science*, No. 58, 1-14, Sept., 1958
167. Piéron, H. Les mécanismes neurooculaires de la vision chromatique. *Ann. Brazil Acad. Sci.*, **26**, 157-62 (1954)
168. Piéron, H. *Aux sources de la connaissance: la sensation, guide de vie*. Part 3, Chapt. II, 171-223 (Librairie Gallimard, Paris, France, 626 pp., 1955)
169. Plateau, J. Bibliographie analytique des principaux phénomènes subjectifs de la vision. Cinquième section. Phénomènes ordinaires de contraste. Sixième section. Ombres colorées. *Mém. acad. roy. Belg.*, **42**, (5) 1-35, (6) 1-38 (1878)

170. Polani, P. E., Bishop, P. M. F., Lennox, B., Ferguson-Smith, M. A., Stewart, J. S. S., and Prader, A. Colour vision studies and the X-chromosome constitution of patients with Klinefelter's syndrome. *Nature*, **182**, 1092-93 (1958)
171. Rand, G., and Rittler, M. C. An evaluation of the AO H-R-R pseudoisochromatic plates. *A.M.A. Arch. Ophthalmol.*, **56**, 736-42 (1956)
172. Ratliff, F., and Hartline, H. K. Fields of inhibitory influence of single receptor units in the lateral eye of *Limulus*. *Science*, **126**, 1234 (1957)
173. Ratliff, F., Miller, W. H., and Hartline, H. K. Neural interaction in the eye and the integration of receptor activity. *Ann. N. Y. Acad. Sci.*, **74**, 210-22 (1958)
174. Rautian, G. N. Thresholds of color discrimination. *Proc. Acad. Sci., U.S.S.R.*, **92**, 943-46 (1953)
175. Rautian, G. N. A new anomaloscope and the classification of colour vision forms. In *Visual Problems of Colour*, **II**, 487-96 (Her Majesty's Stationery Office, London, England, 749 pp., 1958)
176. Remberg, H. Die spektrale Empfindlichkeit des Farbenpercipierenden Mechanismus in Zwielichtsehen und ihre Bedeutung für den Primat der Helligkeits-erregung. *Arch. ges. Physiol.*, **258**, 324-42 (1954)
177. Rendahl, I. The electroretinogram of the light-adapted human eye. *Acta Ophthalmol.*, **36**, 900-16 (1958)
178. Richter, M. The official German standard color chart. *J. Opt. Soc. Am.*, **45**, 223-26 (1955)
179. Richter, M. Die ausgestaltung des Nagelschen Anomaloskops zu einen 'Tritoskop'. *Farbe*, **6**, 5-6 (1957)
180. Riggs, L. A. Human retinal responses. *Ann. N. Y. Acad. Sci.*, **74**, 372-76 (1958)
181. Riggs, L. A., Berry, R. N., and Wayner, M. A comparison of electrical and psychophysical determinations of the spectral sensitivity of the human eye. *J. Opt. Soc. Am.*, **39**, 427-36 (1949)
182. Riggs, L. A., Cornsweet, J. C., and Lewis, W. G. Effects of light on electrical excitation of the human eye. *Psychol. Monographs*, **71**(5), 45 pp. (1957)
183. Riggs, L. A., and Johnson, E. P. Electrical responses of the human retina. *J. Exptl. Psychol.*, **39**, 415-24 (1949)
184. Riggs, L. A., Ratliff, F., Cornsweet, J. C., and Cornsweet, T. N. The disappearance of steadily fixated visual test objects. *J. Opt. Soc. Am.*, **43**, 495-501 ((1953)
185. Rushton, W. A. H. Visual pigments in the colour blind. *Nature*, **182**, 690-92 (1958)
186. Rushton, W. A. H. The cone pigments of the human fovea in colour blind and normal. In *Visual Problems of Colour*, **I**, 71-105 (Her Majesty's Stationery Office, London, England, 749 pp., 1958)
187. Sanders, C. L. Comparison of binocular colour matches with the matches expected from the trichromatic theory of vision. *Farbe*, **4**, 172-74 (1955)
188. Schiess, J. Über die Reproduzierbarkeit gleichheitsphotometrischer Messungen von Spektrallichtern. *Optik*, **9**, 312-18 (1952)
189. Schubert, G., and Bornschein, H. Beitrag zur Analyse des menschlichen Electroretinograms. *Ophthalmologica*, **123**, 396-413 (1952)
190. Ségat, J. *Le Mécanisme de la Vision des Couleurs* (Gaston Doin & Cie, Paris, France, 347 pp., 1953)

191. Shaw, W. A. A new theory of color vision. *Psychol. Rev.*, **63**, 228-42 (1956)
192. Shklover, D. A. The equicontrast colorimetric system. In *Visual Problems of Colour*, **II**, 603-14 (Her Majesty's Stationery Office, London, England, 749 pp., 1958)
193. Sloan, L. L. Congenital achromatopsia; a report of 19 cases. *J. Opt. Soc. Am.*, **44**, 117-28 (1954)
194. Sloan, L. L. The photopic retinal receptors of the typical achromat. *Am. J. Ophthalmol.*, **46**(2), 81-86 (1958)
195. Sloan, L. L., and Hable, A. Tests for color deficiency based on the pseudoisochromatic principle. *A.M.A. Arch. Ophthalmol.*, **55**, 229-59 (1956)
196. Sloan, L. L., and Wollach, L. A case of unilateral deuteranopia. *J. Opt. Soc. Am.*, **38**, 502-9 (1948)
197. Speranskaya, N. I. Methods of determination of the co-ordinates of spectrum colors. In *Visual Problems of Colour*, **I**, 317-23 (Her Majesty's Stationery Office, London, England, 749 pp., 1958)
198. Sperling, H. G. An experimental investigation of the relationship between colour mixture and luminous efficiency. In *Visual Problems of Colour*, **I**, 249-77 (Her Majesty's Stationery Office, London, England, 749 pp., 1958)
199. Sperling, H. G., and Hsia, Y. Some comparisons among spectral sensitivity data obtained in different retinal locations and with two sizes of foveal stimulus. *J. Opt. Soc. Am.*, **47**, 707-13 (1957)
200. Stern, C., and Walls, G. L. The Cunier pedigree of color blindness. *Am. J. Human Genet.*, **9**, 249-73 (1957)
201. Stiles, W. S. Increment thresholds and the mechanisms of colour vision. *Docum. Ophthalmol.*, **3**, 138-63 (1949)
202. Stiles, W. S. The average colour-matching functions for a large matching field. In *Visual Problems of Colour*, **I**, 209-47 (Her Majesty's Stationery Office, London, England, 749 pp., 1958)
203. Stiles, W. S. Color vision: the approach through increment-threshold sensitivity. *Proc. Natl. Acad. Sci. U. S.*, **45**, 100-14 (1959)
204. Stiles, W. S., and Burch, J. M. N.P.L. colour-matching investigation: final report (1958). *Optica Acta (Paris)*, **6**, 1-26 (1959)
205. Svaetichin, G. Spectral response curves from single cones. *Acta Physiol. Scand.*, **39**, Suppl. 134, 17-46 (1956)
206. Svaetichin, G., and MacNichol, E. F., Jr. Retinal mechanisms for chromatic and achromatic vision. *Ann. N. Y. Acad. Sci.*, **74**, 385-404 (1958)
207. Talbot, S. A. Recent concepts of retinal color mechanism. II. Contributions from anatomy and physiology. *J. Opt. Soc. Am.*, **41**, 918-41 (1951)
208. Tessier, M., and Blottiau, F. Variations des caractéristiques photométriques de l'oeil aux luminances photopiques. *Rev. opt.*, **30**, 309-22 (1951)
209. Thomson, L. C. The spectral sensitivity of the central fovea. *J. Physiol. (London)*, **112**, 114-32 (1951)
210. Thomson, L. C. A review of ideas on colour perception. *Ophthalmic Lit.*, **6**, 3-40 (1952)
211. Thomson, L. C. Stimulation of the retina with light fields of small size. *Brit. Med. Bull.*, **9**, 50-54 (1953)
212. Thomson, L. C. Sensations aroused by monochromatic stimuli and their prediction. *Optica Acta (Paris)*, **1**, 93-102 (1954)

213. Thomson, L. C., and Trezona, P. W. The variations of hue discrimination with change in luminance level. *J. Physiol. (London)*, **114**, 98-106 (1951)
214. Thomson, L. C., and Wright, W. D. The colour sensitivity of the retina within the central fovea of man. *J. Physiol. (London)*, **105**, 316-31 (1947)
215. Thomson, L. C., and Wright, W. D. The convergence of the tritanopic confusion loci and the derivation of the fundamental response functions. *J. Opt. Soc. Am.*, **43**, 890-94 (1953)
216. Trezona, P. W. Additivity of colour equations. *Proc. Phys. Soc. (London)*, **66B**, 548-56 (1953)
217. Trezona, P. W. Additivity of colour equations: II. *Proc. Phys. Soc. (London)*, **67B**, 513-22 (1954)
218. Wald, G. Retinal chemistry and the physiology of vision. In *Visual Problems of Colour*, **I**, 7-61 (Her Majesty's Stationery Office, London, England, 749 pp., 1958)
219. Walls, G. L. A branched-pathway schema for the color-vision system and some of the evidence for it. *Am. J. Ophthalmol.*, **39**, 8-23 (1955)
220. Walls, G. L., and Heath, G. G. Typical total color blindness reinterpreted. *Acta Ophthalmol.*, **32**, 253-97 (1954)
221. Walls, G. L., and Heath, G. G. Neutral points in 138 protanopes and deuteranopes. *J. Opt. Soc. Am.*, **46**, 640-49 (1956)
222. Walls, G. L., and Mathews, R. W. *New Means of Studying Color Blindness and Normal Foveal Color Vision* (University of California Press, Berkeley, Calif., 172 pp., 1952)
223. Wassef, E. G. T. Application of the binocular matching method to the study of the subjective appearance of surface colours. *Optica Acta (Paris)*, **2**, 144-50 (1955)
224. Weale, R. A. The foveal and para-central spectral sensitivities in man. *J. Physiol. (London)*, **114**, 435-46 (1951)
225. Weale, R. A. Hue-discrimination in para-central parts of the human retina measured at different luminance levels. *J. Physiol. (London)*, **113**, 115-22 (1951)
226. Weale, R. A. Spectral sensitivity and wave-length discrimination of the peripheral retina. *J. Physiol. (London)*, **119**, 170-90 (1953)
227. Weale, R. A. Cone-monochromatism. *J. Physiol. (London)*, **121**, 548-96 (1953)
228. Weale, R. A. An anomaloscope. *Farbe*, **6**, 1-4 (1957)
229. Weale, R. A. Observations on photochemical reactions in living eye. *Brit. J. Ophthalmol.*, **41**, 461-74 (1957)
230. Wienke, R. E. Empirical derivation of the CIE luminosity curve from color mixture data. *J. Opt. Soc. Am.*, **47**, 622-25 (1957)
231. Willis, M. P., and Farnsworth, D. Comparative evaluation of anomaloscopes. *Med. Research Lab. Rept. 190*, (Bureau of Medicine and Surgery, U. S. Navy, Department, Washington, D. C., 1952)
232. Willmer, E. N. Colour of small objects. *Nature*, **153**, 774-75 (1944)
233. Willmer, E. N. Colour vision in the central fovea. *Docum. Ophthalmol.*, **3**, 194-213 (1949)
234. Willmer, E. N. A physiological basis for human colour vision in the central fovea. *Docum. Ophthalmol.*, **9**, 235-313 (1955)

235. Willmer, E. N. The physiology of vision. *Ann. Rev. Physiol.*, **17**, 339-66 (1955)
236. Willmer, E. N., and Wright, W. D. Colour sensitivity of the fovea centralis. *Nature*, **156**, 119-21 (1945)
237. Winch, G. T., and Young, B. M. Color-rendering of fluorescent lamps and binocular viewing investigations. *Illum. Eng.*, **50**, 353-60 (1955)
238. Wright, W. D. The present status of the trichromatic theory. *Docum. Ophthalmol.*, **3**, 10-23 (1949)
239. Wright, W. D. The characteristics of tritanopia. *J. Opt. Soc. Am.*, **42**, 509-21 (1952)
240. Yurov, S. G. The question of the metrics of brightness. In *Visual Problems of Colour*, **I**, 195-208 (Her Majesty's Stationery Office, London, England, 749 pp., 1958)
241. Yustova, E. N. Variation of colour sensation during adaptation to the colour observed. In *Visual Problems of Colour*, **II**, 681-90 (Her Majesty's Stationery Office, London, England, 749 pp., 1958)
242. Zanen, J., and Meunier, A. Disparité de la perception chromatique chez des jumelles univitellines. *Bull. soc. ophtalmol. Belges*, **118**(2), 356-68 (1958)
243. Zanen, J., Wibail, R., and Meunier, A. Les seuils achromatiques foveaux dans les dyschromatopsies congénitales. *Bull. soc. ophtalmol. France*, **70**, 81-105 (1957)

PERCEPTUAL LEARNING^{1,2}

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In psychology our subject matter keeps confounding our distinctions, and what we have set apart we must always bring together again. So it is with perception and learning. But the distinction here remains, though less clear than it seemed, and we must somehow identify perceptual learning in a context which still holds both perception and learning as separate fields. Lacking recognized boundaries, the reviewer must set up his own landmarks and make the best map he can. To do this he needs a longer time span than is provided by a single year, for a region does not as a rule come suddenly to display distinctive features. The decision to include a chapter with the title "Perceptual Learning" implies a recognition that changes of emphasis or interest have made a separate discussion of this topic seem worth-while. The chapter itself must present these changes as its justification, even if, in order to do so, it must refer to work produced some time ago, and included, in other contexts, in other volumes of the *Annual Review of Psychology*.

Not that perceptual learning as such is a new idea. Since Locke, it has been widely assumed that we learn to manufacture our perceptual experience out of sensory elements. Even when Gestalt psychology challenged this assumption it did so only to claim that sensory elements are not so elementary as the older theory supposed. No one has ever denied that perceptual learning does occur, though the precise nature of the process has always been a little obscure. What has become increasingly apparent over the past decade, however, is that there are data which make several widely-used theoretical formulations rather inappropriate. In particular, the attempt to fit perceptual phenomena into a one-way, causal, $S \rightarrow R$ type of theory is proving troublesome. It seems that we must think of perception as something the organism does, not as something which happens to the organism, and our ways of talking do not always take this into account.

There has been another change, this time on the methodological side. Not so long ago many psychologists would have been reluctant to abandon an objective and vaguely physiological notion like "afferent neural (or stimulus) interaction" in favor of concepts like scanning, inferring, filtering, matching, and guessing. But now we can do something to specify these concepts both formally and objectively, while the older notion remains inaccessible, though, like a household god, it may confer a sense of security by its presence.

To be sure, a study of behavior in any of its aspects can probably be

¹ The survey of the literature upon which this chapter has been based was completed in March, 1959.

² The author would like to express his thanks to Miss D. E. M. Matthews, who was responsible for the secretarial work.

translated into $S \rightarrow R$ terms, but is the effort worth while? Broadbent (23) suggests that to do so is like doing mathematics with Roman numerals—possible but perverse. Thus it is clear that the material to be reviewed here has implications beyond the field of perceptual learning, and is relevant to psychological theory in general.

LANDMARKS

It is not the aim of this section to give a history of perceptual learning theory. A few reference positions are stated in outline in the hope that these may help to identify the field. O'Neil (100) has recently suggested that we can classify theories of perception into three types: (a) discrimination theories, (b) phenomenalist theories, and (c) judgmental theories. For his purpose the scheme works admirably and he has some shrewd things to say, but when interest is concentrated on perceptual learning rather than on perception as such, it seems necessary to make modifications.

JUDGMENTAL THEORIES

The class of judgmental theories, or ratiomorphic theories, to use Brunswik's (29) term, is adequate in both contexts, and we may set it up as the first of our landmarks. Perceiving is here regarded as analogous to thinking. It is more or less skilled, while percepts are often treated as implicit propositions.

Bevan (20), in an intensive survey of perceptual theory, calls attention to the fact that even by the early twenties Woodworth (134) and McDougall (87) were insisting that "Perception is a response, not a picture, an active analyzing and interpreting of signals provided in sensory stimulation." Still further back one may find the same point made by James, Helmholtz, and others, so that it seems a little odd that the Lockeian alternative should have held out so long. Perhaps the vested interests of psychophysics and learning theory may be held responsible. Perhaps, as Wallraff (129) suggests, the weakness of Locke's position has not been sufficiently realized. Certainly Woodworth, writing again on perception (135) after more than a quarter of a century, felt no need to change his views, which had been disregarded rather than refuted in the meantime. Bartlett (11) was another to call attention to the active side of perceiving, though what he said was related more obviously to remembering. One of his pupils, Vernon (126, 127), has pursued a characteristic line of research into visual perception from the middle thirties until the present day.

With some of the same considerations in mind, Ames (5) and his associates put forward what is essentially a philosophical theory with experimental illustrations. According to Ittelson & Cantril (71), "each of us, through perceiving, creates for himself his own psychological environment, by attributing certain aspects of his experience to an environment which he believes exists independent of this experience." The solipsistic implications of "creates" are avoided by refusing to regard perceiver and perceived as

separately given. Both are involved in a continuing "transaction," which is our proper starting point and cannot further be resolved.

If we leave on one side the philosophical aspects of this theory, we find it making the modest claim that our perceived world is what it is because of expectations and assumptions arising from past action. In other words it turns itself into a theory about the strategy of perceiving, a theory which is in line with other theories, though less fully worked out than some. Brunswik thinks that the Ames approach has to do more with the tactics of perceiving; his own theory, by contrast, deals with the strategy. Certainly his theory is wider, and, so far, it has been more influential. For Brunswik, the perceptual world is an achievement rather than a creation, an achievement made possible by the use of cues. These cues acquire, during the lifetime of any individual, an "ecological validity," which is a function of the extent to which each of them has mediated successful action in real life situations. They enable us to guess well, not to know accurately. An investigation of the strategy of perceiving, which is what we really learn, requires, according to Brunswik, a new type of experimental design. The traditional experiment with its two variables only answers a very specific and limited kind of question, while the multifactorial approach, using analysis of variance in situations which have been artificially randomized, would only be appropriate if the chances and events of this world came along like the plots of an agricultural experimenter. A truly "representative" design falls somewhere between these two, and Brunswik himself admits that we lack the statistical tools to handle it.

More influential has been his suggestion that the communication engineers have something to contribute to perceptual theory. Using now familiar terms as defined by Shannon & Weaver (114), he suggests that perceptual cues may be treated as "signals" in "coded messages." He continues:

Whenever the "capacity" of a channel is less than the richness of variability of the source from which it accepts messages, the channel is "overloaded." In this case no code will reduce the error frequency as low as one may please. . . .

The crux of organismic adjustment which we have studied in this book may be rephrased in quite a similar way: distal perceptual and behavioral mediation must, in the nature of things, in the general case, rely on overloaded channels, and the limited dependability of all achievement mechanisms is a result of this overloading.

The most characteristic feature of this view of perceptual learning is its emphasis upon the gradual establishment of cue reliabilities during the lifetime of the perceiving organism. Attneave & Arnoult (9), while claiming that Brunswik "is perhaps the only psychologist who has ever given due weight to the importance of stimulus-sampling, or of situation-sampling in general," admit, as he does, that it is difficult to establish the parameters of a stimulus domain which will meet the conditions of ecological validity.

Attneave, himself, in an earlier paper (8), shows rather ingeniously how information theory might be applied to the visual field, which for this purpose may be regarded as a grid. Admittedly, as Anderson & Leonard (6)

have recently pointed out, the problem of stimulus specification is very much more difficult for visual than it is for auditory material; but, for expository purposes, Attneave's scheme works admirably. He points out that "information is concentrated along contours (i.e., regions where color changes abruptly), and is further concentrated at those points on a contour at which its direction changes most rapidly (i.e., at angles or peaks of curvature)." We utilize this information by extrapolating from regularity, and "the *good gestalt* is a figure with some high degree of internal redundancy." This extrapolation is a reasoning-like process, but we cannot tell in any given case whether it is "intuitive" or "deliberative." Bartlett (12) does not appear to make any hard and fast distinction here; in his recent discussion of thinking, he treats a leap to, or intuition of, a terminal point as equivalent to "an analysis of steps of evidence as presented, and movement through additional steps to the terminal point."

Bruner (24), whose important and continuing contribution in this field has affinities with the work both of Brunswik and Bartlett, is another writer who regards perceiving and thinking as closely akin. However, he preserves Brunswik's point that perceiving is relatively primitive and stereotyped. Illusions, for example, persist even when we know them to be illusory. He outlines his general view of perception as follows. It is a decision process involving the utilization of discriminatory cues—a process which in turn requires inference. The decision is between categories regarded as specifications of equivalence. These categories, in any given situation, are not equally accessible. Veridical perception consists of the coding of stimulus input in appropriate categories. Finally, embodying the notion of ecological validity, perception will be veridical in the degree to which the accessibility of categorizing systems reflects the likelihood of occurrence of the events that the person will encounter. In describing mechanisms which might mediate these processes, Bruner introduces, among others, the notions of gating or screening—so that the input is sorted to some extent before it reaches the higher centers—and matching. In a slightly later paper (25, 26), he makes suggestions for the integration of this kind of theory with what we know about the central nervous system. Following Hebb (62), he has some hard things to say about an association theory which purports to ignore physiology, but, in fact, uses, without realizing it, physiological notions that have long since been discarded.

STIMULATION THEORIES

In his class of phenomenalist theories, O'Neil (100) includes, along with Gestalt psychology, the contributions of Michotte (93) and Gibson (48). These three approaches are related because they all attempt to give an orderly account of how things look. But problems of learning are not, as a rule, raised by phenomenalist theories; however, they are raised by the Gibsons (52). The Gibsons' interest, too, has been more in the stimulus and its specification (49) than in the characteristics of immediate experience.

Consequently, they must find the extent to which the organism can learn to exploit the wealth of stimulus variables offered by its environment, and, in studying the process, the Gibson group have sometimes been quite happy to accept behavioral data [Walk, Gibson & Tighe (128)]. They suggest that the term "stimulation theory," rather than "phenomenalist theory," is appropriate here, though this leaves us with some difficulties since it involves classifying together sensory physiologists at one extreme and Gestalt psychologists at the other. Graham (60) points out that the two major directions of perceptual investigation involve studies of the effects on discriminations of (a) stimulus conditions and (b) past history parameters and conditions of the subject. The Gibson group, by dealing with the molar rather than the molecular stimulus conditions, move in both directions at once, whereas the typical stimulation theorist tries to discount the past history variable, thus falling outside the scope of the present chapter.

There is an assumption implicit in judgmental theories and some associationist theories that the skilled or experienced perceiver "enriches" his sensory input, either with extrapolation and surmise, or with a remembered context. In rejecting this, the Gibsons claim that the dimensions of stimulation are so numerous and varied that we need only learn to use the richness that is given. The claim is well-based since it would seem, from the cogent and ingenious experiments they have carried out, that this wealth exists. On the other hand, one cannot argue from the fact of a bank balance to the act of spending, which is apparently what they advocate. Postman (106) has pointed out that meaning often appears to involve enrichment, as in Titchener's "core-context" theory, though the Gibsons (53) are unwilling to accept this point. Other studies have suggested that one of the features of skilled performance is a reduction of the need for sensory information even when it is available. In a purely discriminative situation, such as the Gibson example of a wine taster, their case may seem convincing, but the experienced operator in a sequential task appears to disregard much of what is presented to him and to function in terms of inference and anticipation. Bresson (22a) makes this point when he distinguishes between discriminative and associationist learning. Discriminative learning involves the extraction of invariants from the flow of sensory information, but associationist learning involves expectation of sequence, strategies, and criteria for decision among competing possibilities. There is a possible way out if we bring information theory to bear on the situation. The Gibsons might well claim that what has happened is that the operator has detected the redundancies, and ignored them, and is thus still responding to features of the stimulus which his skill enables him to identify. Even so, there are some unresolved conflicts here which current research may help to clarify.

ASSOCIATION THEORIES

The Gibsons might have claimed the term discrimination theory for their own, and, in fact, do so when they distinguish between discrimination and

enrichment as the basis for perceptual learning. At the same time, discrimination is a widely used concept in learning theory, generally. It will be best, so as to avoid prejudging the issue which the Gibsons have raised, to replace O'Neil's type "discrimination theories" with "association theories" since these include enrichment as well. Additional weight is given to the suggestion by the fact that O'Neil included under his "discrimination" heading theories which are here classified under "stimulation."

It is difficult to identify a contemporary theory of perception which can be taken to represent the position of Locke or even Titchener. This may be because learning theory concerns itself either with overt behavior or with inferred variables that have no necessary connection with conscious experience. It is possible to talk in Hullian terms of the patterning of stimulus compounds and the consequent ineffectiveness of unreinforced stimuli, but this does scant justice to the richness of our data. Or we may take Hebb's neurological models of the cell assembly and phase sequence to be associationist by implication; yet, for all their ingenuity—Mark I (61) or Mark II (94)—they only take us so far towards an understanding of perceptual learning, though they certainly make it easier for the squeamish behaviorist to avoid the use of mental terms. What may prove more fruitful in Hebb's work is his emphasis upon the motor-kinaesthetic component in perception.

Skinner (118) makes a characteristic attempt to translate perceptual problems into behavioral, rather than neural, language. "Conditioned seeing" explains why one tends to see the world according to one's previous history. Familiar objects and events reinstate themselves and elicit appropriate behavior when stimuli merely suggest that they may be present. This seems to be an enrichment theory in the Gibson sense. "Operant seeing," or the "discriminative response of seeing," together with the verbal behavior which may be used by the subject to describe it, are handled rather ambiguously. The evidence for the discrimination must be a response, but what about the discrimination itself? This is not a question about "private seeing" in the introspective sense, but about selective and, possibly, inferential processes operating at the input stage.

This problem of perceiving as a response other than fixating or listening or handling has produced some interesting experimental work and, more especially, some extremely ingenious theorizing. Perhaps the "pure stimulus act" is an incantation rather than a theory and should be treated as such; but the "mediation process" is an important innovation which makes learning theory much better able than it was to handle perceptual data. Even if we think of the mediation process as merely selective, it transforms the traditional $S \rightarrow R$ formulation. Osgood (101), for instance, uses a two-stage $S \rightarrow X \rightarrow R$ mediation theory to handle results reported by Lawrence (84, 85) and others which raise difficulties for a single-stage theory. Osgood, Suci & Tannenbaum (102) have since gone on to explore the possibilities of the mediational hypothesis in the field of meaning, and the first stage of an important empirical quantification has been published by Jenkins, Russell

& Suci (72). Kendler (75) reports a number of other encouraging studies. But $S \rightarrow X \rightarrow R$ is a little clumsy; it may obscure the fact that we respond to the stimulus as mediated and not to the mediation process. It seems clear that the important relationship is $S \rightarrow X$ rather than $X \rightarrow R$, and, in consequence, many learning problems might be better stated as problems of perception.

ADAPTATION THEORIES

Finally, there seem to be grounds, at least in a preliminary survey of this kind, for introducing a fourth class, namely, "adaptation theories." Speaking of Kohler's (78) interesting and important experiments in which various types of prism are worn before the eyes for long periods, Hochberg (67) suggests that

Two kinds of association between distal and/or proximal stimuli (including tactual-kinesthetic feedback stimulation) in our visual environment can be distinguished, namely, invariable relations ($r \geq 1.0$) and contingent relations ($r < 1.0$). Where an invariable relationship occurs, instead of repeating it in each perceptual response, it becomes "partialled out" as norm, framework, or neutral point.

Helson (65) had already called attention to the importance of this phenomenon.

One of the chief characteristics of organic patterning is found in the establishment of neutral, indifferent, or zero regions of functioning in all types of behavior. These neutral regions represent the organism's centering with respect to the stimuli confronting it and are the true zeros of functioning.

The range of phenomena to be included under the rubric "adaptation" as used by Helson is quite wide, and there are some who would make it even wider. At one extreme there is sensory adaptation. Resembling sensory adaptation, but with distinctive features, are some of the findings reported by Kohler (79). For example, prisms with gross chromatic aberration when worn in front of the eyes produce blue or orange fringes along vertical gradients of illumination in the visual field. After two or three days, when the prisms are removed, fringes in the complementary colors appear. These are anchored to objects and do not move with the eyes. Similar results have been obtained with colored half-fields.

The type of "figural after-effect," first described by Gibson (47), seems to fall in the same category; indeed Gibson's work and that of Kohler on adaptation to curvature in the visual field are in complete agreement. As McEwen (88) has pointed out, this type of adaptation effect seems different from the displacement effects described by Köhler & Wallach (80).

At the other extreme, adaptation in Helson's sense seems to come very close to habituation as discussed by Thorpe (124). Thorpe defines habituation as "the relatively persistent waning of a response as a result of repeated stimulation which is not followed by any kind of reinforcement." Partialling out the familiar and irrelevant is a basic kind of adjustment, related to extinction but not the same thing. It gives a field of investigation, already

entered by Berlyne & Slater (19) and others, in which problems of perception, motivation, and learning can be dealt within the same context.

Finally, it would seem that adaptation theory, with its concept of the "functional zero," may well form an essential part of any full-scale attempt to apply information theory to the perceptual field. If information is to be thought of as a departure from some base line, this line cannot be the absence of stimulation but rather stimulation at a neutral or indifferent level.

CURRENT RESEARCH

New books.—Using these landmarks, it is possible to locate most, but not all, current research.³ Among the exceptions are theoretical discussions, such as those by O'Neil and Bevan already mentioned. These discussions are on the whole not unduly partisan, and seem to reflect a general trend towards integration of the different approaches. Other exceptions are investigations of particular problems in which neither the topic nor the method gives a clue to theoretical affiliation.

Bartley (13) has published a general account of perception which is theoretically rather elusive. The author's main contribution has been to the study of stimulation, and he writes as an experimentalist unused to verbal-theoretical maneuvering. Like Allport (3), he lists 13 types of theory, but not quite the same 13, suggesting that they all contain some truth. Nonetheless, he feels he must "build anew" rather than identify himself with one or other of the listed possibilities, though his new building incorporates bricks from various sources. Perception is "the immediate response of an organism to the energy impinging on sense organs," and it is discriminatory. On the other hand, perception is not stimulus-bound: it is symbolic, evaluative with reference to an indifference point, prognostic, and consistent. Though perception is distinguished from thinking as involving a discrimination among immediately present stimuli, it is like thinking in many ways. The organism builds a "language" for itself out of its encounters with the external world, and we must know this language, as well as the physical properties of the stimuli, if we are to understand perception. At the same time, the learning by which the language is acquired can only be approached through perception, so it is difficult to see whether perception or learning is the prior study. Bartley clearly does not hold a stimulation theory of the Gibson type, but he incorporates adaptation theory, and on the whole seems judgmental rather than associative in linking perception so closely with thinking. Though his exposition is not always clear, he makes a number of penetrating points. One may be quoted:

Terminology must be developed to dispel the present verbal ambiguity between what is stimulus and what is response. Avoiding the use of the same words for both is the very first step in this direction.

³ It should be made clear that in assigning papers to different regions the reviewer is not presuming to identify the theoretical allegiance of their authors. At the end of his survey of the literature he did a card-sort which others might well have done differently.

Two new books have come from Cambridge, one by Welford (131) and the other, already mentioned, by Broadbent. Since both these authors were pupils of Bartlett, they might be expected to occupy a position somewhere in the region of the judgmental landmark.

Welford, in a characteristically clear and economical account of perception, holds that it involves three types of process: identification, setting in a context, and determining significance for ensuing action. Identification "involves placing the object presented to our senses in one of a number of categories provided by our past experience." Setting in a context is the process by which objects are related to the spatio-temporal framework in which they occur, while determining significance for action involves a computing or extrapolation whereby perception in a familiar environment is enabled to keep a little ahead of events, and so make possible sequential integration of behavior. Welford's point of view is clearly judgmental as far as this last process is concerned. The first process involves categorizing. However, Welford does not say much about the way in which a spatio-temporal setting is provided, a setting upon which perception of movement and causal relationships depend. This problem has been worked on by Piaget & Lambercier (104). Their contribution is a distinctive one which provides a useful corrective to the prevalent view that action influences visual perception only because it leads to reinforcement or confirmation. Action in an environment which is also seen makes possible an integration between the visual and the tactile-kinesthetic modes. We cannot give a purely visual account of visual causality. A second paper by Piaget & Maroun (105) shows the occurrence of "assimilations" and "exchanges" between the visual and the tactile-kinesthetic modes. The paper suggests that what takes place is the construction of a common schema not restricted to either. Gemelli & Cappellini (46) stress the same point. Gestalt-like factors cannot account for everything we find in Michotte-type experiments on causality. Active intervention of the subject is required to integrate the data into a meaningful whole. Evidence in support of the same view is provided by Goldstone, Boardman & Lhamon (59), who show that in estimating short time intervals six- and seven-year-olds must count, but by eight the "action" component has been incorporated in perception, and counting is no longer necessary.

A related study, however, by Fraisse & Orsini (44) suggests that some caution is necessary in asserting that there are genetic stages in the development of our estimation of time intervals. Though six-year-olds tend to overestimate in comparison with eight and ten-year-olds, learning is quite rapid, and all three groups soon acquire comparable skill with training.

Broadbent has approached perception from the study of auditory phenomena and has made some interesting theoretical suggestions in the light of his experimental data. In terms of our classification, his extensive use of information theory would place him in the judgmental group, but it is significant that there is very little philosophy and a great deal of "physiologizing" in what he has to say.

He takes advantage of the fact that in hearing, as distinct from vision, it

is possible to present the subject with more than one stimulus at the same time without peripheral adjustments biasing the competition between them. His data force him to distinguish between the arrival of a stimulus at a sense organ and use of the information which it conveys. There is also a need to consider the whole ensemble of possible stimuli rather than the presence or absence of each one. Both of these make an $S \rightarrow R$ formulation extremely clumsy. Information theory, on the other hand, not merely overcomes this difficulty, but, in addition, makes it possible to bring to bear upon perceptual problems a more genuinely mathematical type of theorizing than can be found in an *a posteriori* system like Hull's, festooned as it is with empirical constants. Broadbent himself does not use information theory in a quantitative way, but the models he refers to, particularly a theoretical model invented by Deutsch (35), and some real hardware constructed by Uttley (125), provide his theorizing with essentially quantitative analogies. It may be felt by some that model building is an occupational disease with information theorists in the field of behavior. Models prove nothing, and competitive ingenuity can become trivial, but they do force their builders to be explicit and quantitative in their thinking, especially if they are of the hardware variety. Rosenblatt (110) has recently described a new theoretical model which is probabilistic and, on the whole, associative in its basic structure. He extends it, however, in the direction of Attneave when he points out that the performance of the system can be improved by the use of a contour-sensitive projection area, and by the use of a binary response-system, in which each response or "bit" corresponds to some independent feature or attribute of the stimulus. Here again the objectivity and quantifiability of the model are merits, but its applicability is as yet not fully established.

The gist of Broadbent's argument is that the organism as perceiver can be regarded as a limited-capacity channel preceded by a filter. The properties of this filter reduce to selective threshold changes, but the variables effecting these changes are quite numerous. At one end, simple adaptive changes occur which desensitize the organism to continuing irrelevant stimuli; at the other, the conditional probabilities of a sequence are computed, and expected events, if they are also relevant, come to have prior access.

There are interesting data which suggest the existence of a short-term storage system (immediate memory) to which a signal may be diverted while a response is being made to its competitor. The long-term storage system, which is described in terms of conditional probabilities, is located on the output side of the limited-capacity channel, although it has an important feedback loop to the selective filter. This last is clearly the key concept, particularly so far as perceptual learning is concerned. Broadbent uses it to handle adaptation, extinction, attention, expectancy, and even relates it to motivational factors. To a large extent, this is a statement of program, but the data, as far as they go, are solid enough, and the theoretical possibility of an integration of learning theory and information theory is clearly present.

Here again, therefore, the trend is towards unity with a bias in favor of a judgmental type of approach.

Although the first volume of Koch's (77) survey is general and theoretical, it does not attempt to put forward a single point of view, nor even, at this stage, to identify a trend. Rather it is a cross section in which some significant contemporary positions are exhibited side by side. By a fortunate coincidence, the positions which most nearly concern us are at three of our four landmarks and close to the other. Postman & Tolman (107) describe Brunswik's probabilistic functionalism; Gibson (51) and Helson (66) speak for themselves; while Hebb (64) has to stand, meantime, until Volume 2 appears, as a marginal representative of the associationists.

The Postman & Tolman paper is largely expository, but the authors call attention to the convergence of probabilistic functionalism and "mediational" theories of learning on a set of common empirical problems. Hebb, too, treats the mediating process as making possible reconciliation between hitherto divergent views. In his case, ideation as "a process which can be aroused sensorily but which can also occur in the absence of the adequate stimulus" if treated as a surrogate or mediating process is felt to "supplement (instead of contradicting) the stimulus response approach to behavior."

Gibson, on the other hand, does not feel a need to be reconciled with anybody. He restates his position that

for every aspect of property of the phenomenal world of an individual in contact with his environment, however subtle, there is a variable of the energy flux at his receptors, however complex, with which the phenomenal quality would correspond if a psychophysical experiment could be performed.

In meeting possible objections to this statement, Gibson confirms a suspicion that he is advocating a definition rather than propounding a theory. To perceive is to differentiate, and differentiation implies a difference. For example, "d" is different from "a" because it has a tail and not because the reader knows more or fewer words beginning with either letter. Similarly, "a" is not different from "a," if the typographer has done his job properly, and no enrichment by association or inspired guessing will help. The advantage of this definition is that it forces the psychologist to take the stimulus seriously, as Gibson himself has done. As to the learning processes involved, Wohlwill (133) suggests that they grow out of the generalization of previously established differential responses to a new stimulus. Perceptual learning need not depend on the formation of new S→R associations and, in contrast to associative learning, may occur in the absence of external reinforcement. While it is true that this kind of learning does occur, and may be the kind of thing to which the term perceptual learning is best applied, the scope of Gibson's definition is much wider and holds under conditions which are obviously associative or judgmental in character.

In specifying the differentiations, Gibson has developed his perceptual psychophysics, and, by so doing, has provided psychology with a valuable

research tool and with a program for its use which should prove extremely fruitful in new insights. It may be significant that a recent paper by him (50) was entitled "The Information Contained in Light," though he himself does not describe his higher-order variables of visual stimulation in information-theory terms. This task has recently been carried out by Sidorsky (117), who showed that perspective transformation of a grid could readily be interpreted in terms of pitch angle as seen by a pilot landing a plane.

Helson's statement of adaptation level theory is rather wide for our purposes and extends far beyond the perceptual field. He accepts Kohler's point that the first step towards organization within perception is the establishment of a "null point" which is related to the characteristics of the stimulus milieu of the organism and cannot be derived merely from contemporary stimulation. The experimental evidence here is good, and the only question that seems to arise is whether we can use the term "learning" for phenomena of this kind, that is, shifts in quantitative judgments, figural after-effects, adaptation to prolonged distortion, habituation, and so on. Reinforcement is not essential, though nonreinforcement sometimes seems to play an important part. If we do call this class of phenomena learning, it is a variety of perceptual learning, and one cannot easily reduce it to association, stimulus differentiation, or ratiomorphic processes. Whether adaptation level can be generalized as widely as Helson suggests and used in fields other than the perceptual is another matter. Stevens (121) thinks not. "It sometimes happens," he says, "that when a pregnant and useful principle developed in one domain is carried over into other areas by reason of an apparent analogy, we tend to lose sight of distinctions that ought to be preserved." He would like to avoid treating sensory adaptation as no more than a special case of "semantic adjustment" or "judgmental relativity." No sensory changes lie behind the statement that a large mouse is walking up the trunk of a small elephant. The point is well taken, but seems to go too far. The intermediate changes found in experiments with distorted or colored visual fields seem to be central rather than sensory, as do figural after-effects if they belong in this context. Cohen & Tepas (31) report that prolonged exposure to a tilted frame and rod significantly increased errors in judgment of verticality. Here, too, after-effects were obtained. It may be that we should distinguish between this kind of change and sensory adaptation in the strict sense, but the analogy is so striking that the use of the same term for both seems justified. For our present purposes there is no need to follow Helson any further afield.

Woodworth (136) once again shows his perennial accessibility to new ideas, and indeed produces some himself, in a discussion of motivation perception and learning in the light of recent experimental work. It is a textbook whose point of view is, again characteristically, middle of the road as between judgmental and mediation process theories of perception, but it does not purport that the simple $S \rightarrow R$ possibility need any longer be seriously taken into account. The "perceptual utilization of stimuli" is an

intervening variable between the perception of stimuli and the motor performance, but it is more than that. There is a translation or decoding of stimuli and stimulus combinations into information about the environment. Thus perception means the use of stimuli as cues of objects, their sizes and distances, what they are doing, and what they are likely to do. In learning to perceive, we learn the properties of the objects in our environment.

The use of "decoding" for the transition from stimulus to mediation process, instead of the more usual "coding," seems correct here, as does the suggestion that we "encode" the response before transmitting it to the periphery.

The "question-and-answer process," though Woodworth suggests it may be a new idea, seems no more than a concrete way of indicating some of the phenomena covered by rather more technical terms, such as "hypothesis" and "vicarious trial and error."

On the whole one could be inclined to place Woodworth in the judgmental group, but his use of the word "cue" makes it unnecessary for him to commit himself on a number of crucial issues. A cue is sometimes like a clue, the starting point for an inferential process. Sometimes, however, it means no more than a signal which triggers off an existing set. Of course a judgmental theory is also a mediation theory, and history may have committed us to a false antithesis here.

Hebb (63), too, has produced an excellent textbook of modest dimensions. His views are quite close to Woodworth's, though sometimes he uses very different language in which to express them. Perception is a mediating process distinguishable from sensation, which is also a mediating process closer to the stimulus. A distinction is also made between perceiving, which is an activity extended in time with, as a rule, feedback from motor responses, and the percept which is its product. A percept is a "resetting of the switch-board" or a change in the central nervous system, "transient or lasting, which will modify any of an indefinitely large class of responses to subsequent stimuli." This sentence taken literally seems to imply that perceptual learning is essentially an input process.

Hebb goes on to point out that the relationship between stimulus and percept is variable quite apart from the one-way changes that might be called adaptation or learning. He also distinguishes between two kinds of generalization—series generalization, which seems inherent in the sensory rather than the perceptual process, and pattern generalization, which is perceptual and is rather difficult to explain in the light of our present knowledge.

Though Hebb does not call attention to the link himself, his reiteration of his earlier views that the motor processes form an essential part of perceiving and perceptual learning is in line with work by Piaget and others already mentioned. It would seem that the nature of the sensori-motor interactions involved at the perceptual level requires further study.

An investigation in the same area by Mooney (95), however, showed that the subsequent recognizability of novel visual configurations immediately following the first experience with them is no greater with longer viewing time to permit scanning. This seems to tell against Hebb's early views as to the importance of eye-movement, but it may be specific to the nonsense figures that were used.

Theoretically, Hebb is a mediation theorist here as elsewhere, but he is no easier than Woodworth to place in a continuum between judgmental and associationist. His model building might place him towards the first landmark with Broadbent for company, but Osgood, in other contexts, is clearly a close neighbor. It may well be that in a few years' time the present landmarks will have become inconspicuous and a new triangulation will be required.

Papers in the region of judgmental theory.—Bruner's (27) contribution during the year under review, as might be expected after his *annus mirabilis* of 1957, consists mainly of a restatement without essential modification of views he has already expressed. Like Welford, he now puts forward three functions for perception, or three strategies, to use his characteristic adaptation of Brunswik's term. They are not the same three, but show some affinities. The first is the means whereby organisms regulate the intake of information, both with respect to amount and kind. The second is aimed at reducing disruptive surprises by taking advantage of the conditional probabilities of event sequences. The third involves the determination of perceptual selectivity by the needs and purposes of the perceiving organism. In construing "strategy," we must bear in mind, as has already been pointed out, that Bruner, unlike some judgmental theorists, draws an explicit distinction between perceiving and thinking. The selective threshold changes of the first and third strategies, as well as the quasi-inferential processes of the second, derive from intrinsic characteristics of the neural mechanisms involved. It may be that Bruner's own physiologizing strategy sometimes involves him in leaping gaps where his less nimble colleagues would pause on the brink, but he is just as serious as Broadbent, or Hebb for that matter, in rejecting a "black box" approach.

In a short research paper, Bruner & Wechsler (28) report that when a subject must choose under conditions of uncertainty he uses the nature of the series as a whole. When one of two possible states has occurred he becomes set to expect the other. This is similar to Broadbent's findings that a pointer movement on one of a number of dials makes it less likely that a second movement will be detected immediately afterwards on the same dial.

The topic of subception is marginal in the field of perceptual learning, as it is in other fields, but it might be thought to have some bearing on the location of Broadbent's "filter" or Bruner's "gate." Klein *et al.* (76) have combined the "meta-contrast" technique of rapidly successive stimuli with an adaptation of the method devised by Engel (38) for fusing different pictures in a stereoscope. They report that when two different figures are pre-

sented in rapid succession only the second is consciously perceived, but what is seen is influenced by the "unseen" prior stimulus.

Dixon (36) found it possible to obtain galvanic skin response changes with emotionally toned but unrecognized words. By matching the subject's verbal response to the appropriate stimulus and to synonyms, it was possible to show that "meaning" must have been involved.

More relevant to judgmental theory is a finding by Hoisington & Spencer (70) that the recognition of familiar words in the marginal field of vision is in part a function of expectation operating through what they call "adjustive states of the organism." More marginal again is the report from Shevrin & Luborsky (116) that we can get evidence from free association and dreams suggesting that some features of a slide projected too rapidly for conscious perception are none the less registered.

On the other hand, Goldiamond (56) surveys the whole field of subception and concludes:

It is questionable whether the studies cited indicate discrimination without awareness, unconscious processes in perception, and the like, or demonstrate discrepancies in and between indicators. These discrepancies can be functions of pairing an apparently invalid indicator with one made less sensitive by admitting invalidating variance, or by using procedures which artificially inflate threshold and thereby make it appear that processes related to receipt of information are going on at below-threshold levels.

There are good grounds for believing that many of the phenomena reported as examples of subception can be dealt with as Goldiamond suggests, but it would be wrong to think of subception as entirely dependent upon the existence of anomalous data in the same way that extrasensory perception depends on such data. Any theory which incorporates the notion of a selective filter operated by the content rather than the purely sensory characteristics of the stimulus must somehow find place for a feed-back loop whereby certain kinds of input, as it were, exclude themselves.

Even an inferential or judgmental theory in the widest sense may be logically forced to distinguish between reception of the stimulus and operations upon the stimulus, both occurring before the stage of conscious awareness..

A neat example of the operation of a complex perceptual set is provided by Culbert (33). In experiments in which the subjects have to solve anagrams in mirror-image, they can do so better if the conditions for mirroring are obviously present, that is, if they view the anagrams in a mirror rather than watch the mirror-images projected onto a screen. Tausch (123) has done some important work on the nature of the inferential processes involved in perceptual constancy. Though his statement is cast in a phenomenalist mould, it is not so far removed from speculative engineering as to make translation impossible. He distinguishes schematically between the "old" theory of size constancy and his own. The old theory makes size constancy depend on an unconscious (Tausch suggests "subconscious") inference fol-

lowing a conscious perception of depth. Tausch holds that the depth component is embodied in the stimulus and directly produces size constancy. The representative significance of the stimulus may become conscious, but this is additional to and has no influence upon the processes leading to size constancy.

Work has been carried out in Italy during the past few years on the Ames demonstrations. Two reports, by Canestrari & Minguzzi (30) and Costa (32), suggest that we cannot fully explain the oscillatory movement of the trapezoidal window in terms of unconscious inference from our assumptions about a familiar object. There are autochthonous factors involved as well. This is in line with the finding by Allport & Pettigrew (4) that, with African subjects who have had no opportunity to see rectangular windows, the illusion persists, though less strikingly.

Joynson (74) has also published data on size constancy which may be relevant here. He shows that associationist and Gestalt psychologists have each produced too emphatic an answer in their own support by leaving uncontrolled certain variables. These include instructions to subjects, angle of separation between standard and variable, and whether the comparisons are successive or simultaneous. The most important variable is the first, which determines whether the subject will give an R (real) judgment, or an N (other than real, including phenomenal judgment). The conclusion is that both present stimuli and past experience are involved in both kinds of judgment. There seems to be a further conclusion, not explicitly drawn, that they are used inferentially. It is possible that future exploration of this region between full conscious awareness on the one hand and complete absence of stimulation on the other can be more easily carried out in the auditory field using the methods described by Broadbent. More sensitive techniques are beginning to appear in vision too, however. Anderson & Leonard, in a paper already referred to, show how information theory can be adapted to analyze the factors involved in visual identification tasks. Most interesting, and related to stimulus theory in rather a basic way, is the finding that subjects utilize only the amount of information called for by the perceptual task that has been set. Identification and classification require only some of the information to be used, and that is what the subjects tend to see. Reconstruction, on the other hand, requires the use of all information presented. The implications of this study for a consideration of the relative value of a behavioral or phenomenalist approach are obvious. Anderson & Fitts (7) investigated the amount of information gained during brief exposures of numerals and colors. They related the span of apprehension to information transmitted, type of coding, and information displayed. It appears that we cannot specify perceptual ability in terms of some simple index like, for example, the number of objects seen. The type of coding is also important, and, where it is done by the subject, seems to be one of the key operations in perception about which we need to know a great deal more. To call it a skill does not take us very far, though Davis & Cullen (34) have shown that, in neurotic and psychotic patients, per-

ception shows a pattern of breakdown similar to that found in motor skill. Perhaps with the recent refinements of technique and formulation we should concentrate for the time being upon the accumulation of data.

Such data are being accumulated. Newbrough (99) reports that, if we apply information theory at the quantitative level to visual recognition, we must specify two variables, the total stimulus information and specific stimulus information. With both these, prediction is possible, but the second alone is not enough. Elliott (37) has shown that we are not merely following current fashion when we move across from phenomenalism to information theory. Judgments of figural complexity for random shapes are not only consistent but also correlate highly with the Arnoult scale based upon amount of information. Some help in locating the coding process is provided by Krulee (83), who finds that restriction on the number of response alternatives simplifies the task of form discrimination only if this restriction enables the subject to ignore the dimensions containing the most difficult discriminations.

Verbal material has been used by Aborn & Rubenstein (1) to study an aspect of "ecological validity." Words perceived in a given context as being more probable tend to be those occurring with greater probability in that context, but the subjects limit the possibilities envisaged to a number very much less than the theoretically possible alternatives. Bruner's notion of "accessibility" is clearly another way of handling the same data. Rosenzweig & Postman (111), summing up the findings in this field for a wider audience, claim that word identification is easier when the word population from which selection must be made is restricted, that intelligibility varies directly with frequency of usage, and that, if frequency of usage is held constant, word intelligibility also varies directly with length.

Goldiamond & Hawkins (58), however, question whether these phenomena are perceptual at all. Using an experimental technique which presumably depends to some extent upon the fact that their subjects have heard of subception, they asked the subjects to guess which of a number of nonsense syllables previously exposed more or less frequently had appeared during a light flash with no content. A logarithmic relationship was found between training frequency and response frequency. They draw the conclusion that their results, which are similar to those obtained under marginal conditions of perceiving, require us to modify the widely accepted perceptual word-frequency-recognition relationship by admitting that what may be learned is a response bias.

A subsequent study by Goldiamond (57) confirms the findings with letters and other material, manipulating such variables as restriction of population as has been done with word material. The conclusions drawn, however, seem more relevant to subception than to perceptual learning, but enough evidence is presented to show the presence of a possible contaminating variable in experiments using tachistoscopic or other marginal types of presentation. Also with verbal material, Rau (108) carried out an investigation into the determinants of ambiguity. She found that meaningfulness, clarity, and

instructional set are all important and interact with one another. Consequently, in any given experiment all three must be specified.

Kornadt (82), though primarily concerned with memory, has something to say about perception too. He followed the methods of Bartlett and others to study the constructive aspects of reproduction. In his conclusions he uses some of Bruner's ideas to explain his findings, and also follows Bartlett in the view that we cannot distinguish as sharply between perceiving and remembering or thinking as the task of exposition sometimes seems to require.

Finally, Binder (21) approaches categorizing behavior with an interest in personality characteristics. Using cue data as his variable, he shows that the willingness of subjects to categorize on inadequate information is related to other personality characteristics. Perceiving, therefore, is not to be thought of merely as a skill which is learned more or less well; it is also a clinically useful performance by the perceiver. This point has, of course, been made before, but Binder's method seems to offer more hope for quantification than some of its predecessors.

Papers in the region of stimulation theory.—Johansson (73), like Gibson, raises the problem of learning, but in rather a different way. Gibson, one feels, would like to banish problems of learning from the study of perception, at least until the task of stimulus specification has been properly carried out. Johansson is not happy about this; in accepting Gibson's general view of the need for a higher-order psychophysics, he points out that the choice of a gradient system for any actual percept should not be determined by considerations of mathematical elegance, but should be related to the subject's past experience and actual expectancy. He would thus seem to favor a coming together of stimulation and judgmental theories, and, indeed, places his own position somewhere between those of Gibson and Vernon. This is an important paper since it seems to retain most of what is distinctive in stimulation theory while avoiding the rather polemical approach which sometimes obscures the real nature of the theory's claims.

On the other hand, Musatti (98) and Hochberg (68) both take the view that our first task is to express the perceptual world in terms of mathematical transformations. Johansson might well accept this on the grounds that we can more easily identify what our subject is doing if we know the possibilities from which he has to select. Perhaps Hochberg goes too far when he says that the present task of perception psychologists is to predict subjects' perceptual responses from characteristics of the stimulus field, but, like Gibson, he shows that we must take the stimulus variable seriously under all circumstances. He follows Gibson, too, in the direction of information theory when he points out that real spatial motion theoretically can yield more redundant information than pictures, though the extent to which this information is used by the organism must be determined empirically.

Von Fieandt (127a), however, while accepting the need for a fuller optical and physical description of the higher-order variables, holds that the phe-

nomenological approach is still paramount in perception. He would probably take the line that model-building is a harmless diversion for ingenious psychologists with time to spare, but it is not psychology.

The possible complexity of these higher-order variables may not have been taken seriously enough by those who talk about optical or geometrical specification, Gibson excepted. For example, Engen, Levy & Schlosberg (39) carried out a dimensional analysis of facial expressions. Using 48 photographs, they asked their subjects to rate in terms of "pleasant-unpleasant," "attention-rejection," and "sleep-tension." The high reliabilities they obtained make it clear that some objective properties of the stimulus must have been involved. Brunswik & Reiter's schematized faces suggest a possible way out. Simplification may show that only a few variables are relevant. At the same time, Frijda (45) has shown that situational cues are also involved in this kind of judgment, presumably as making possible empathic identification with the people portrayed. Not all the conditions would seem to be present in the faces themselves, though no doubt they are available in the total stimulus, as Gibson would contend.

Papers in the region of the associationist landmark.—Almost any discussion of the mediation process might be regarded as concerned with perceptual learning, while a narrower interpretation might restrict the term to investigations in which only perceptual variables have been employed. The possibility of this second usage was raised earlier in connection with Wohlwill's theoretical analysis. Data of a purely perceptual kind were presented a quarter of a century ago by Leeper (86), who complained then that there was a tendency to try to fit all kinds of learning into a single framework. He showed that subjects would spontaneously structure fragmented or ambiguous pictures, that their structuring was influenced by a previously induced set, and that, once it had taken place, it was rather difficult to change. Perhaps data reported by Forgas (42, 43) are in some respects similar, or, at any rate, owe their existence to some sort of spontaneous but persistent structuring. He investigated the effects of pre-exposure to visual forms without reinforcement upon subsequent learning of form discriminations in rats. He describes the forms he used in the sort of information-theory terms suggested by Attneave. They were triangular in outline, but some had angles and some had not. None was a complete triangle. Later, when a circle and a triangle were used as test figures, it was found that those subjects who had been exposed to the figures without angles were superior. Forgas concludes that the effects of earlier experience are not dependent only on familiarity and reinforcement, but also upon the extent to which the relationship between the early forms and the task forms leads to selective responding to the difference between the task forms. Gibson *et al.* (46a) report a similar carry-over from visual patterns exposed on cage walls. In their experiment, pre-exposure was found to help discrimination between the same and similar patterns but made no difference with dissimilar ones. This kind of "knowledge by acquaintance," which plays a part in recog-

nition, may, as Leeper suggests, be *sui generis*, but too little is known about it to say more.

The wider mediation type of learning theory seems by all accounts to be the only theory with associationist antecedents which tries to cope with all the data from the perceptual field. Mention has already been made of publications indicating that the gap between this kind of theory and judgmental theory is closing rapidly, but whether the gap will disappear completely remains uncertain. Berlyne (14) claims that "if we think of the perceptions which constitute the 'phenomenal world,' etc., as reactions to physical energy changes, and overt behavior in its turn as a reaction to them, we may be able to enjoy the benefits of both points of view." Against this we have Bartley's warning about the dangers of treating a stimulus as a response and vice versa, as well as Broadbent's complaint about the clumsiness of the $S \rightarrow R$ formulation in the field of perception.

Nonetheless, Berlyne (15) continues to support his attempts at theoretical integration with experimental studies in the field of exploratory behavior (16, 17). He reports that complexity and novelty, both of which are perceptual variables which could be expressed in information theory terms, bring about an increase in fixation time when two visual stimuli are presented simultaneously. This suggests at once the round-eyed wondering gaze of the young child in the presence of something new and strange. Berlyne (18) has followed up the suggestion with infants between three and nine months, with results in line with his hypothesis.

Barnett (10) has published an extensive survey of the literature on exploratory behavior in animals which should provide a useful starting point for future research. The notions of stimulus hunger and stimulus satiation to be found in this literature provide a possible link between a wide range of perceptual and motivational phenomena. Glanzer (55) gives an information-theory version of the findings in this area. He suggests that we may regard the organism as an information processing system that requires certain amounts of information per unit time. If this is not available, the organism becomes active to increase it. Where too much information is available, selectivity operates to decrease it. The amount of information required varies with past experience and age.

A rather unusual role is assigned to perception by Mackay (90). He takes up the old problem of the stable world despite voluntary head and eye movement and the moving world with forced rotation of the eyeball, suggesting that we do not need to assume processes of "compensation" or "abstraction." If we adopt an information-flow model and regard stability as the norm, we have then to account for perception of change. Suppose, as Bartlett and others have done, that there is a schematic "organizing system" within the organism responsible for adaptive activity. Perception might thus be regarded as the way in which this system is kept up to date. Changes in perception would occur only when sufficient information is provided by the receptors to justify it. Where there is no mismatch between the organizing

system and receptor information, the perceived world remains stable. The signals generated as a consequence of voluntary movement are redundant so far as the system responsible for such movement is concerned. If retinal changes did not occur, then there would be a mismatch and the world would seem to be unstable. Perception is thus not associated with the functioning of a filter, but with the adaptive response which it evokes or guides in the organizing system.

It may be significant as showing the present permeability of the boundary between judgmental and association theories that the transition from Berlyne, who is on one side of it, to Mackay, who is on the other, seems to have taken place so easily. This is not to say that they would agree with one another.

Moving back again towards the field of associative learning, but still close to the borderline, Bourne & Pendleton (22) report a quantitative study of concept identification as related to completeness and probability of information feedback. They are concerned to specify more fully a paper by Restle (109) in which cue validity in perception was defined in terms of the proportion of reinforcement in probability situations. With a correction for the "relevance" variable, Restle's views are corroborated.

Perceptual studies using the more traditional learning theory variables have been comparatively few in number. McNamara, Solley & Long (91) presented profiles tactually in pairs, with a shock to either followed by an ambiguous profile. The conditions were escape vs. no escape. They found that, as the shock increases, so does the tendency to perceive the nonshocked profile. Escape and low levels of shock tended to favor the shocked profile. Working with reward rather than punishment, Walters (130) showed that, where certain colors are given "values" by associating them with rewarding conditions, they come to have different characteristics when used to mediate identification within Gottschaldt-like figures. Similarly, Hochberg & Brooks report (69) that, in visual recognition by brightness contrast, thresholds can be raised by pairing an annoying auditory stimulus with visual forms which are later embedded in more complete patterns.

Working on the reinforcement side, Sandström & Weinz (113) used both praise and reproof in a localization task. Without knowledge of results, performance tended to fall off during the course of the experiment. Motivation as judged by performance appeared to be more uniform in the reproof group, but this may have been a by-product of the frustration in the rewarded group at finding themselves unable to improve their performance and, so, increase the reward.

Muenzinger & Evans (97) report that a secondary cue associated with a gap in the floor of an alley leading to food is more disorganizing in its effects upon the behavior of rats than is the same cue associated with a shock. In the first case there is a disturbance of the perceptual or cognitive structure, and in the second a disturbing event which is "irrelevant." This notion of perceptual structures also arises in connection with Leeper's early paper.

There is probably quite a lot of information about them in the literature in one guise or another, and no doubt more has been lost because investigators were looking for something else. An applied paper by Allan (2), on the learning of Morse code by presenting groups or patterns instead of individual symbols, reports a sensitivity to the "disrupting" or out-of-place symbol long before any detailed learning has occurred. Incongruity is a concept that might well reward a more extensive study than has yet been made. For example, Florès (41) has shown by correlation studies that recognition and recall are not merely two manifestations or two stages of the same process, but show a degree of functional independence suggesting that several related processes are involved.

Papers in the region of adaptation theory.—It must not be assumed that, because a number of papers on figural after-effects have been grouped together in this section, the explanation of these effects in terms of adaptation level is accepted. Some can be dealt with easily in this way, but not all.

Spitz (119) has made an extensive survey of the evidence for and against the Köhler-Wallach theory of satiation. He takes the view that there are still a number of possible explanations in existence, but he does consider adaptation theory might be extended to include all the data. McEwen (89) and Malhotra (92) consider that figural after-effects are in part peripheral and in part due to central factors of a judgmental kind. Malhotra goes on to argue that, when the peripheral effects are observed and then the presentations are repeated without any other conditions being changed, the subjects "expect" that the effects will still be present and so perceive them. Wertheimer & Leventhal (132) take a somewhat similar view. They show that kinesthetic after-effects may be maintained for quite long periods. This persistence is related to the amount of daily inspection given during the test period. Here, again, the conditions under which the subjects first perceived the effects are repeated in each of the test sessions, and a cognitive explanation for the data seems at least possible.

It is difficult to assess the theoretical implications of a study by Spitz & Blackman (120), who compared mentally retarded and normal subjects on visual figural after-effects and reversible figures. They found that the retarded subjects show poorer satiation, slower dissipation of after-effects, and greater rigidity in reversing. This may be another facet of the finding reported by Köhler & Adams (81) that satiation and figural after-effects vary directly with the attentiveness of subjects.

In a study of the effects of exposure time and intertrial interval upon the Müller-Lyer illusion, Mountjoy (96) found that the illusion diminishes as a function of number of trials, and that the decrement is more rapid with increased exposure time. His subjects, however, showed a spontaneous recovery of the illusion after 24 hours.

Studies of the quantitative aspects of perception are more directly relevant to adaptation theory, and some interesting work has been done. None of it, however, appears to have been undertaken explicitly to explore the pos-

sibilities of Helson's formulation. Rudel (112) studied the response of children to size. He found it impossible to separate the absolute and relative properties of stimuli, suggesting that neither should be regarded as more primitive or basic. He does, however, provide support for Gibson's view of perceptual learning as something which proceeds by differentiation of originally complex stimulus patterns. Sherif, Taub & Hovland (115) investigated the effects of anchoring stimuli on judgments of weight. Two such effects appear to exist—assimilation, where an adjacent anchor produces displacement towards itself, and contrast, where a more remote anchor produces displacement away from itself. Tajfel (122) reopens the discussion of another source of displacement or shift in judgments of magnitude, namely value. He points out that value scales exist or can be constructed, and a study of the interaction of such scales with one which is based upon physical magnitudes offers possibilities of considerable theoretical and practical interest.

SUMMING UP

Now that our four landmarks have served their purpose, we must remind ourselves that they are reference positions and not bounded territories. If we start to think in terms of boundaries, the area of perceptual learning structures itself differently. The basic contention of stimulation theory is that we must specify the stimulus properly, not allowing our thinking to be dominated by sensory physiology. This must be accepted whatever account we wish to give of perceptual learning. Otherwise, as Gibson has pointed out, we shall tend to make the organism invent the perceptual world instead of discover it. Similarly, Helson's view that perceptual activity starts from shifting functional zeros, and not from absolute thresholds, is well backed by experimental evidence and can be incorporated into different types of perceptual theory. Here, again, the sensory physiologist may grumble, not because he has contrary evidence, but because he may feel that his task is being unnecessarily complicated.

The judgmental and associationist possibilities are on a different footing. Although each of them can, and probably should, incorporate stimulation and adaptation theories, these potentialities seem at variance with one another. The word "seem" is used deliberately, for the choice is not clear-cut, and the boundary region is becoming less and less well defined. Nonetheless, a trend can be identified, though its extrapolation into the future is attended with some risk. Many of us will remember the mixed feelings aroused during the late thirties and early forties by Tolman's work. The experiments were striking, the rhetoric persuasive, but could this really be science? As we did our running-back-and-forth in front of cognitive theories and response theories, torn between our data and our sense of scientific respectability, the respectability tended on the whole to emerge decisive. Hull, with his seeming rigor and promise of quantification, appeared to be the leader we must follow. Now things are very different, and data from the field of perception are in part responsible. Associationist learning theory, where it has tried to hold

to a strict $S \rightarrow R$ pattern, appears to be lapsing into an esoteric scholasticism. Where it has abandoned $S \rightarrow R$ in favor of $S \rightarrow X \rightarrow R$, there are complaints that it is struggling to say things which must be said, but doing so in a language which is no longer appropriate. There are those who hold that the insights to which Tolman clung with such good-humored obstinacy can now be best exploited by the use of information theory. The selective, classificatory, and inferential activities of the organism are held to make an approach from the direction of the stimulus unnecessarily circuitous. There may be a false antithesis here, and, in any case, the task of stimulus specification remains with us; but the trend seems to be towards the judgmental point of view.

It may be, of course, that theorizing, like perceiving, is a ratiomorphic, not a rational, process; the fact that some of our formulations are plainly inappropriate is not enough to bring about their abandonment. A paper by Penrose & Penrose (103) may be used to illustrate this point. It is called "Impossible Objects," and shows a few. Perhaps we have impossible theories, too, and can do just as little about them.

LITERATURE CITED

1. Aborn, M., and Rubenstein, H. Perception of contextually dependent word-probabilities. *Am. J. Psychol.*, **71**, 420-22 (1958)
2. Allan, M. D. A pattern recognition method of learning Morse code. *Brit. J. Psychol.*, **49**, 59-64 (1958)
3. Allport, F. H. *Theories of Perception and the Concept of Structure* (John Wiley & Sons, New York, N. Y., 709 pp., 1955)
4. Allport, G. W., and Pettigrew, T. F. Cultural influence on the perception of movement; the trapezoidal illusion among Zulus. *J. Abnormal Social Psychol.*, **55**, 104-13 (1957)
5. Ames, A., Jr. *The Nature of our Perception, Prehensions, and Behavior* (Princeton University Press, Princeton, N. J., 130 pp., 1955)
6. Anderson, N. S., and Leonard, J. A. The recognition, naming, and reconstruction of visual figures as a function of contour redundancy. *J. Exptl. Psychol.*, **56**, 262-70 (1958)
7. Anderson, N. S., and Fitts, P. M. Amount of information gained during brief exposures of numerals and colors. *J. Exptl. Psychol.*, **56**, 362-69 (1958)
8. Attneave, F. Some informational aspects of visual perception. *Psychol. Rev.*, **61**, 183-93 (1954)
9. Attneave, F., and Arnoult, M. D. The quantitative study of shape and pattern perception. *Psychol. Bull.*, **53**, 452-71 (1956)
10. Barnett, S. A. Exploratory behaviour. *Brit. J. Psychol.*, **49**, 289-310 (1958)
11. Bartlett, F. C. *Remembering* (Cambridge University Press, Cambridge, England, 317 pp., 1932)
12. Bartlett, F. C. *Thinking: An Experimental and Social Study* (George Allen & Unwin, Ltd., London, England, 203 pp., 1958)
13. Bartley, S. H. *Principles of Perception* (Harper & Brothers, New York, N. Y., 482 pp., 1958)
14. Berlyne, D. E. Attention, perception and behavior theory. *Psychol. Rev.*, **58**, 137-46 (1951)

15. Berlyne, D. E. Uncertainty and conflict: a point of contact between information-theory and behavior-theory concepts. *Psychol. Rev.*, **64**, 329-39 (1957)
16. Berlyne, D. E. The influence of complexity and novelty in visual figures on orienting responses. *J. Exptl. Psychol.*, **55**, 289-96 (1958)
17. Berlyne, D. E. Supplementary report: complexity and orienting responses with longer exposures. *J. Exptl. Psychol.*, **56**, 183 (1958)
18. Berlyne, D. E. The influence of the albedo and complexity of stimuli on visual fixation in the human infant. *Brit. J. Psychol.*, **49**, 315-18 (1958)
19. Berlyne, D. E., and Slater, J. Perceptual curiosity, exploratory behavior, and maze learning. *J. Comp. Physiol. Psychol.*, **50**, 228-32 (1957)
20. Bevan, W. Perception: Evolution of a concept. *Psychol. Rev.*, **65**, 34-35 (1958)
21. Binder, A. Personality variables and recognition response level. *J. Abnormal Social Psychol.*, **57**, 136-42 (1958)
22. Bourne, L. E., Jr., and Pendleton, R. B. Concept identification as a function of completeness and probability of information feed-back. *J. Exptl. Psychol.*, **56**, 413-20 (1958)
- 22a. Bresson, F. Les relations entre perception et apprentissage. Quelques problèmes théoriques et expérimentaux. *Psychol. franc.*, **3**, 165-76 (1958)
23. Broadbent, D. E. *Perception and Communication* (Pergamon Press, London, New York, Paris, Los Angeles, 338 pp., 1958)
24. Bruner, J. S. On perceptual readiness. *Psychol. Rev.*, **64**, 123-52 (1957)
25. Bruner, J. S. Neural mechanisms in perception. *Psychol. Rev.*, **64**, 340-58 (1957)
26. Bruner, J. S. Mécanismes neurologiques dans la perception. *Arch. psychol.*, **36**, 1-28 (1958)
27. Bruner, J. S. The economy of perceiving. In *Proc. 15th Intern. Congr. Psychol.*, 341-42 (North-Holland Publishing Co., Amsterdam, Netherlands, 658 pp., 1959)
28. Bruner, J. S., and Wechsler, H. Sequential probability as a determinant of perceptual closure. *Am. J. Psychol.*, **71**, 604-6 (1958)
29. Brunswik, E. *Perception and the Representative Design of Psychological Experiments* (University of California Press, Berkeley, Calif., 154 pp., 1956)
30. Canestrari, R., and Minguzzi, G. F. Contributions expérimentales à l'interprétation de quelques-unes des démonstrations de Ames dans la perception. In *Proc. 15th Intern. Congr. Psychol.*, 271-72 (North-Holland Publishing Co., Amsterdam, Netherlands, 658 pp., 1959)
31. Cohen, W., and Tepas, D. Temporal factors in the perception of verticality. *Am. J. Psychol.*, **71**, 760-63 (1958)
32. Costa, A. M. Processus perceptifs visuels. In *Proc. 15th Intern. Congr. Psychol.*, 275-76 (North-Holland Publishing Co., Amsterdam, Netherlands, 658 pp., 1959)
33. Culbert, S. S. Facilitation of mirror-image word identification by mirror-image perceptual set. *J. Exptl. Psychol.*, **56**, 344-48 (1958)
34. Davis, D. R., and Cullen, J. H. Disorganization of perception in neurosis and psychosis. *Am. J. Psychol.*, **71**, 229-37 (1958)
35. Deutsch, J. A. A machine with insight. *Quart. J. Exptl. Psychol.*, **6**, 6-11 (1954)
36. Dixon, N. F. The effect of subliminal stimulation upon autonomic and verbal behavior. *J. Abnormal Social Psychol.*, **57**, 29-36 (1958)
37. Elliott, L. L. Reliability of judgments of figural complexity. *J. Exptl. Psychol.*, **56**, 335-38 (1958)

38. Engel, E. The role of content in binocular resolution. *Am. J. Psychol.*, **69**, 87-91 (1956)
39. Engen, T., Levy, N., and Schlosberg, H. The dimensional analysis of a new series of facial expressions. *J. Exptl. Psychol.*, **55**, 454-58 (1958)
41. Florès, C. Étude sur les processus d'utilisation de la trace mnésique. Le rappel, la reconnaissance et le réapprentissage. *L'Année. psychol.*, **58**, 25-43 (1958)
42. Forgus, R. H. The effect of different kinds of form pre-exposure on form discrimination learning. *J. Comp. Physiol. Psychol.*, **51**, 75-78 (1958)
43. Forgus, R. H. The interaction between form pre-exposure and test requirements in determining form discrimination. *J. Comp. Physiol. Psychol.*, **51**, 588-91 (1958)
44. Fraisse, P., and Orsini, F. Étude génétique de l'estimation de la durée. *L'Année psychol.*, **58**, 1-6 (1958)
45. Frijda, N. H. Facial expression and situational cues. *J. Abnormal Social Psychol.*, **57**, 149-54 (1958)
46. Gemelli, A., and Cappellini, A. The influence of the subject's attitude in perception. *Acta Psychol.*, **14**, 12-23 (1958)
- 46a. Gibson, E. J., Walk, R. D., Pick, H. L., Jr., and Tighe, T. J. The effect of prolonged exposure to visual patterns on learning to discriminate similar and different patterns. *J. Comp. Physiol. Psychol.*, **51**, 584-87 (1958)
47. Gibson, J. J. Adaptation, after-effect, and contrast in the perception of curved lines. *J. Exptl. Psychol.*, **16**, 1-31 (1933)
48. Gibson, J. J., *The Perception of the Visual World* (George Allen & Unwin, Ltd., London, England, 235 pp., 1950)
49. Gibson, J. J. Visually controlled locomotion and visual orientation in animals. *Brit. J. Psychol.*, **49**, 182-94 (1958)
50. Gibson, J. J. The information contained in light. In *Proc. 15th Intern. Congr. Psychol.*, 261-62 (North-Holland Publishing Co., Amsterdam, Netherlands, 658 pp., 1959)
51. Gibson, J. J. Perception as a function of stimulation. In *Psychology: A Study of a Science*, 456-501 (Koch, S., Ed., McGraw-Hill, New York, N. Y., 710 pp., 1959)
52. Gibson, J. J., and Gibson, E. J. Perceptual learning: differentiation or enrichment? *Psychol. Rev.*, **62**, 32-41 (1955)
53. Gibson, J. J., and Gibson, E. J. What is learned in perceptual learning? A reply to Professor Postman. *Psychol. Rev.*, **62**, 447-50 (1955)
55. Glanzer, M. Curiosity, exploratory drive, and stimulus satiation. *Psychol. Bull.*, **55**, 302-15 (1958)
56. Goldiamond, I. Indicators of perception: I. Subliminal perception, subception, unconscious perception: an analysis in terms of psychophysical indicator methodology. *Psychol. Bull.*, **55**, 373-411 (1958)
57. Goldiamond, I. Some variables affecting the classic familiarity-recognition relation, when obtained without the presence of discriminative stimuli (Unpublished data, 1959)
58. Goldiamond, I., and Hawkins, W. F. Vexiersuch: The log relationship between word-frequency and recognition obtained in the absence of stimulus words. *J. Exptl. Psychol.*, **56**, 457-63 (1958)
59. Goldstone, S., Boardman, W. K., and Lhamon, W. T. Kinesthetic cues in the development of time concepts. *J. Genet. Psychol.*, **93**, 185-90 (1958)

60. Graham, C. H. Sensation and perception in an objective psychology. *Psychol. Rev.*, **65**, 65-76 (1958)
61. Hebb, D. O. *Organization of Behavior* (Wiley, New York, N. Y., 355 pp., 1949)
62. Hebb, D. O. The role of neurological ideas in psychology. *J. Personality*, **26**, 39-55 (1951)
63. Hebb, D. O. *A Textbook of Psychology* (W. B. Saunders Co., Philadelphia, Pa., 276 pp., 1958)
64. Hebb, D. O. A neuropsychological theory. In *Psychology: A Study of a Science*, 622-43 (Koch, S., Ed., McGraw-Hill, New York, N. Y., 710 pp., 1959)
65. Helson, H. Perception. In *Theoretical Foundations of Psychology*, Chap. 8, 348-89 (Helson, H., Ed., Van Nostrand, New York, N. Y., 787 pp., 1951)
66. Helson, H. Adaptation level theory. In *Psychology: A Study of a Science*, 565-621 (Koch, S., Ed., McGraw-Hill, New York, N. Y., 710 pp., 1959)
67. Hochberg, J. E. Effects of the Gestalt revolution: the Cornell symposium on perception. *Psychol. Rev.*, **64**, 73-84 (1957)
68. Hochberg, J. E. Spatial representation. In *Proc. 15th Intern. Congr. Psychol.*, 265-67 (North-Holland Publishing Co., Amsterdam, Netherlands, 658 pp., 1959)
69. Hochberg, J. E., and Brooks, V. Effects of previously associated annoying stimuli (auditory) on visual recognition thresholds. *J. Exptl. Psychol.*, **55**, 490-91 (1958)
70. Hoisington, L. B., and Spencer, C. Specific set and the perception of "subliminal" material. *Am. J. Psychol.*, **71**, 263-69 (1958)
71. Ittelson, W. H., and Cantril, H. *Perception: A Transactional Approach* (Double-day & Co., Inc., New York, N. Y., 33 pp., 1954)
72. Jenkins, J. J., Russell, W. A., and Suci, G. J. An atlas of semantic profiles for 360 words. *Am. J. Psychol.*, **71**, 688-99 (1958)
73. Johansson, G. Rigidity, stability, and motion in perceptual space. *Acta Psychol.*, **14**, 359-70 (1958)
74. Joynton, R. B. An experimental synthesis of the associationist and Gestalt accounts of the perception of size. *Quart. J. Exptl. Psychol.*, **10**, 65-76, 142-54 (1958)
75. Kendler, H. H. Learning. In *Ann. Rev. Psychol.*, **10**, 43-88 (Farnsworth, P. R., and McNemar, Q., Eds., Annual Reviews Inc., Palo Alto, Calif., 520 pp., 1959)
76. Klein, G. S., Spence, D. P., Holt, R. R., and Gourevitch, S. Cognition without awareness: subliminal influence upon conscious thought. *J. Abnormal Social Psychol.*, **57**, 255-66 (1958)
77. Koch, S. (Ed.) *Psychology: A Study of a Science* (McGraw-Hill, New York, N. Y., 710 pp., 1959)
78. Kohler, I. *Über Aufbau und Wandlungen der Wahrnehmungswelt* (Rohrer, Vienna, Austria, 118 pp., 1951)
79. Kohler, I. Die Methode des Brillenversuchs in der Wahrnehmungspsychologie mit Bemerkungen zur Lehre der Adaptation. *Z. exptl. angew. Psychol.*, **3**, 381-417 (1956)
80. Köhler, W., and Wallach, H. Figural after-effects. *Proc. Am. Phil. Soc.*, **88**, 269-357 (1944)
81. Köhler, W., and Adams, P. A. Perception and attention. *Am. J. Psychol.*, **71**, 489-503 (1958)

82. Kornadt, H.-J. Experimentelle Untersuchungen über qualitative Änderungen von Reproduktionsinhalten. *Psychol. Forsch.*, **25**, 353-423 (1958)
83. Krulee, G. K. Some informational aspects of form discrimination. *J. Exptl. Psychol.*, **55**, 143-49 (1958)
84. Lawrence, D. H. Acquired distinctiveness of cues: I. Transfer between discriminations on the basis of familiarity with the stimulus. *J. Exptl. Psychol.*, **39**, 770-84 (1949)
85. Lawrence, D. H. Acquired distinctiveness of cues: II. Selective association in a constant stimulus situation. *J. Exptl. Psychol.*, **40**, 175-88 (1950)
86. Leeper, R. A study of a neglected portion of the field of learning—the development of sensory organization. *J. Genet. Psychol.*, **46**, 41-75 (1935)
87. McDougall, W. *Outline of Psychology* (Charles Scribner's Sons, New York, N.Y., 456 pp., 1923)
88. McEwen, P. *Figural After-Effects*. *Brit. J. Psychol., Monograph Supplements*, **31** (Cambridge University Press, Cambridge, England, 106 pp., 1958)
89. McEwen, P. Figural after-effects, retinal size and apparent size. *Brit. J. Psychol.*, **50**, 41-47 (1959)
90. Mackay, D. M. The stabilization of perception during voluntary activity. *In Proc. 15th Intern. Congr. Psychol.*, 284-85 (North-Holland Publishing Co., Amsterdam, Netherlands, 658 pp., 1959)
91. McNamara, H. J., Solley, C. M., and Long, J. The effects of punishment (electric shock) on perceptual learning. *J. Abnormal Social Psychol.*, **57**, 91-98 (1958)
92. Malhotra, M. K. Figural after-effects: an examination of Kohler's theory. *Acta Psychol.*, **14**, 161-98 (1958)
93. Michotte, A. *La perception de la causalité* (Studia Psychologica, Louvain, Belgium, 296 pp., 1954)
94. Milner, P. M. The cell assembly: Mark II. *Psychol. Rev.*, **64**, 242-52 (1957)
95. Mooney, C. M. Recognition of novel visual configurations with and without eye movements. *J. Exptl. Psychol.*, **56**, 133-38 (1958)
96. Mountjoy, P. T. Effects of exposure time and intertrial interval upon decrement to the Müller-Lyer illusion. *J. Exptl. Psychol.*, **56**, 97-102 (1958)
97. Muenzinger, K. F., and Evans, W. O. Effect of substituting a secondary cue for a gap upon a visual discrimination. *Psychol. Repts.*, **4**, 211-13 (June, 1958)
98. Musatti, C. L. Les caractères perceptifs des objets et la théorie mathématique des groupes. *Acta Psychol.*, **14**, 41-53 (1958)
99. Newbrough, J. R. Interaction between total stimulus information and specific stimulus information in visual recognition. *J. Exptl. Psychol.*, **55**, 297-301 (1958)
100. O'Neil, W. M. Basic issues in perceptual theory. *Psychol. Rev.*, **65**, 348-61 (1958)
101. Osgood, C. E. Selective Thinking. In *Method and Theory in Experimental Psychology*, 444-73 (Oxford University Press, New York, N. Y., 800 pp., 1953)
102. Osgood, C. E., Suci, G. J., and Tannenbaum, P. H. *The Measurement of Meaning* (University of Illinois Press, Urbana, Ill., 342 pp., 1957)
103. Penrose, L. S., and Penrose, R. Impossible objects: a special type of visual illusion. *Brit. J. Psychol.*, **49**, 31-33 (1958)
104. Piaget, J., and Lambercier, M. La causalité perceptive visuelle chez l'enfant et chez l'adulte. *Arch. Psychol.*, **36**, 77-201 (1958)
105. Piaget, K., and Maroun, J. La localisation des impressions d'impact dans la causalité perceptive tactilo-kinesthésique. *Arch. Psychol.*, **36**, 202-35 (1958)

106. Postman, L. Association theory and perceptual learning. *Psychol. Rev.*, **62**, 438-446 (1955)
107. Postman, L., and Tolman, E. C. Brunswik's probabilistic functionalism. In *Psychology: A Study of a Science*, 502-64 (Koch, S., Ed., McGraw-Hill, New York, N. Y., 710 pp., 1959)
108. Rau, L. Variability in response to words: an investigation of stimulus-ambiguity. *Am. J. Psychol.*, **71**, 338-49 (1958)
109. Restle, F. Theory of selective learning with probable reinforcements. *Psychol. Rev.*, **64**, 182-91 (1957)
110. Rosenblatt, F. The Perceptron: a probabilistic model for information storage and organization in the brain. *Psychol. Rev.*, **65**, 386-408 (1958)
111. Rosenzweig, M. R., and Postman, L. Frequency of usage and the perception of words. *Science*, **127**, 263-66 (1958)
112. Rudel, R. G. Transposition of response to size in children. *J. Comp. Physiol. Psychol.*, **51**, 386-90 (1958)
113. Sandström, C. I., and Weinz, E. Effects of praise and reproof in a localization experiment. *Acta Psychol.*, **14**, 137-43 (1958)
114. Shannon, C. E., and Weaver, W. *Mathematical Theory of Communication* (University of Illinois Press, Urbana, Ill., 117 pp., 1949)
115. Sherif, M., Taub, D., and Hovland, C. I. Assimilation and contrast effects of anchoring stimuli on judgments. *J. Exptl. Psychol.*, **55**, 150-55 (1958)
116. Shevrin, H., and Luborsky, L. The measurement of preconscious perception in dreams and images: an investigation of the Poetzel phenomenon. *J. Abnormal Social Psychol.*, **56**, 285-94 (1958)
117. Sidersky, R. C. Absolute judgments of static perspective transformations. *J. Exptl. Psychol.*, **56**, 380-84 (1958)
118. Skinner, B. F. *Science and Human Behavior* (The Macmillan Co., New York, N.Y., 461 pp., 1953)
119. Spitz, H. H. The present status of the Köhler-Wallach theory of satiation. *Psychol. Bull.*, **55**, 1-28 (1958)
120. Spitz, H. H., and Blackman, L. S. A comparison of mental retardates and normals on visual figural after-effects and reversible figures. *J. Abnormal Social Psychol.*, **58**, 105-10 (1959)
121. Stevens, S. S. Adaptation-level vs. the relativity of judgment. *Am. J. Psychol.*, **71**, 633-46 (1958)
122. Tajfel, H. Quantitative judgement in social perception. *Brit. J. Psychol.*, **50**, 16-29 (1959)
123. Tausch, R. Nichtbewusste (sog. unbewusste) Vorgänge bei der optischen Grössenwahrnehmung von Gegenständen. *Psychol. Forsch.*, **25**, 28-64 (1955)
124. Thorpe, W. H. *Learning and Instinct in Animals* (Methuen, London, England, 493 pp., 1956)
125. Uttley, A. M. The conditional probability of signals in the nervous system. *Radar Research Establishment Memorandum, No. 1109* (London, England, 1955)
126. Vernon, M. D. *Visual Perception* (Cambridge University Press, Cambridge, England, 248 pp., 1937)
127. Vernon, M.D. *A Further Study of Visual Perception* (Cambridge University Press, Cambridge, England, 289 pp., 1952)
- 127a. Von Fieandt, K. Towards a unitary theory of perception. *Psychol. Rev.*, **65**, 315-20 (1958)
128. Walk, R. D., Gibson, E. J., and Tighe, T. J. Behavior of light-and-dark-

- reared rats on a visual cliff. *Science*, **126**, 80-81 (1957)
129. Wallraff, C. F. John Locke and the *Zeitgeist* of the present: a criticism of Boring's account of Locke's "ideas." *Am. J. Psychol.*, **71**, 443-48 (1958)
130. Walters, R. H. Conditioning of attention as a source of autistic effects in perception. *J. Abnormal Social Psychol.*, **57**, 197-201 (1958)
131. Welford, A. T. *Ageing and Human Skill* (Oxford University Press, London, England, 300 pp., 1958)
132. Wertheimer, M., and Leventhal, C. M. "Permanent" satiation phenomena with kinesthetic figural after-effects. *J. Exptl. Psychol.*, **55**, 255-57 (1958)
133. Wohlwill, J. F. The definition and analysis of perceptual learning. *Psychol. Rev.*, **65**, 283-95 (1958)
134. Woodworth, R. S. *Psychology: A Study of Mental Life* (Henry Holt & Co., Inc., New York, N.Y., 580 pp., 1921)
135. Woodworth, R. S. Reinforcement of perception. *Am. J. Psychol.*, **60**, 119-24 (1947)
136. Woodworth, R. S. *Dynamics of Behavior* (Henry Holt & Co., Inc., New York, N.Y., 403 pp., 1958)

PSYCHOLOGICAL ASPECTS OF AGING¹

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Since the previous review (1956) there has been a sharp increase in the literature reporting research on aging. In comparison with published research on child development, however, the total literature on the psychology of aging is small. Thus, research on aging remains one of the large, relatively unexplored areas in psychology, one in which psychology has a vital role, both singly and in a matrix of other sciences. Research on aging may be approached in three ways: (a) as a basic field of inquiry in its own right, (b) as a source of experiments for hypothesis testing within the conceptual framework of established theories in other areas of psychology, and (c) as an applied field for developing methods of meeting the immediate needs of older persons. The last of these is a vast area beyond the scope of this review. The present review is primarily concerned with the subject matter of basic research on aging as psychologists view it.

Some confusion has arisen over the proper terms to use in designating the present subject matter. Child psychology is not the same as pediatrics or embryology, although the three fields have some interests in common. Similarly, the psychology of aging has some subject matter in common with geriatrics and gerontology but the terms are not interchangeable. In the reviewer's opinion, terms like "geriatric psychology" and "gerontological psychology" are not very useful. Although the psychology of aging is part of the broader subject of developmental psychology, it will be apparent in this review that there are differences in emphasis between research and theory of child psychology and the psychology of the post-maturational period. The term "aging" in this review refers to the regularities or chains of events which occupy a significant portion of the latter part of the life span, resulting in differences between young and old organisms in structure and function.

RECENT DEVELOPMENTS

More books are appearing which are presenting a life-span developmental psychology: Zubek & Solberg (378), Pressey & Kuhlen (278), and Hurlock (143). *Vita Humana*, a new journal giving emphasis to a life-span developmental psychology, has also appeared. Several major research projects which started out as longitudinal studies of children have become studies of aging: Terman's gifted children are being followed into their middle years, as are the subjects of the Fels and Berkeley studies of growth and adolescence. The former Institute of Child Welfare at Berkeley has become the Institute of Human Development in recognition of its interests in research on all phases of the life span. There are also indications that departments of psychology are

¹ This review covers the period April, 1955 to April, 1959.

beginning to include courses on aging as part of developmental psychology sequences.

In 1956 a report of a research conference on the psychological aspects of aging was published (6) which contains a very useful bibliography of the earlier literature, as well as discussions of research problems. The publication of this report in several ways marks the beginning of an organized body of knowledge and interest in the psychology of aging. One of the features of the early research on aging was the relative inaccessibility of the literature. The research report of 1956 made it apparent that a volume, similar to the *Manual of Child Psychology*, was needed for the psychology of aging. What was called for was an authoritative technical summary of the literature on the behavioral aspects of aging for reference use as well as for use in graduate and undergraduate instruction in a field which was essentially unorganized. Such a handbook appeared in 1959 (19) and contained chapters of 24 collaborators who prepared comprehensive reviews of a previously scattered literature. Like the *Manual of Child Psychology*, the *Handbook of Aging and the Individual* expresses an interest in individual differences in relation to social-cultural background. But, in addition, it contains a relatively greater emphasis on biological relations, particularly in the anatomy and physiology of the nervous system.

Another recent development was Federal action calling a White House Conference on Aging for January, 1961, which will encourage research on aging. The Council of State Governments has already made recommendations for research and training which bear upon research on the psychology of aging.

THEORY

Characterization of the psychological aspects of the aging organism as a whole is difficult and, at present, most rudimentary. Studies of limited aspects of the organism have been emphasized, and in the near future we will probably see few attempts to identify general antecedent conditions for large clusters of age changes, although it seems desirable to continue to increase our scope of theorizing about the natural phenomena of aging (19, 165, 194, 280, 285). The data contained in the *Handbook of Aging and the Individual* make it necessary to accept the fact that there are many reliable and systematic differences, of psychological interest, between young and old individuals in properties of the nervous system (28, 138, 218), sensory and perceptual processes (41, 365), psychomotor skills (366), mental abilities (152), personality and adjustment (184), drives and emotions (34), and learning (148). These differences presumably arise in the accumulated effects of experience or endogenous biological properties. It is not incompatible with a long-range interest in manipulating these differences for man's benefit to stress a present necessity to gain an understanding of the nature of the phenomena and to develop theoretical models of the determinants of the processes of aging (5).

An important book by Comfort (71), the *Biology of Senescence*, makes a distinction on an evolutionary basis between the determinants of growth and development and those of aging. Comfort holds that selective pressures to survive have resulted in orderly and determinate "programs" of development for the various organisms. In contrast, no selective pressures have been able to operate in the case of aging, since reproduction has stopped by the time individual longevity and late-life characteristics appear. If animals have been unselected for postmaturational traits, a basic question may be raised: What kind of a model will be suitable to account for the systematic differences in animals with age and for fixed-species life span? To follow Comfort's reasoning, aging would be characterized by the wearing-out or breakdown of a "program," with, as a consequence, a kind of disorganized vulnerability to environmental circumstances, any one of which might terminate the life span. The idea of a determinate course of growth and development, followed by a disorderly phase of breakdown, is reflected in probabilistic models.

One of the more interesting facts that theories of aging have to account for is the relation of parental age to longevity and other characteristics of offspring. The symposium edited by Miner (236) cites a considerable literature on this relation. One of the possibilities is that there are two channels of heredity, one nuclear (genes), and the other cytoplasmic. The latter may within some genetic (nuclear) limits accumulate and transmit influences to offspring. Because of the different evolutionary pathways of different species, it is not likely that there is a single mechanism of aging, but many, with species specificity.

Birren (19) suggests that the general characteristics of systems which age are (a) irreversibility, (b) cumulation, and (c) limits of size, form, and function. Reichenbach & Mathers (280) pointed out that irreversibility gives the organism the property of unidirectionality in time; with this property alone organisms could display continuous unidirectional growth or development. Organisms, at least mammals, do not grow continuously, but decelerate to some limit in form, size, and function. After limits of growth are reached, the accumulation of effects may reduce the organism's adaptive capacity, including that for survival, and changes may be seen in the resistive and restorative processes.

Emphasis in theory about aging is on mechanisms which register and accumulate effects; two systems which seem to possess these features to a special extent are the nervous system and the immunological system. Both seem to record events in such a way as to influence markedly the manner in which the organism reacts in future situations of the same sort. If diseases occur at irregular intervals, the registration of events would be aperiodic. Several theories of aging include as an essential feature the idea of random insults. Models of aging patterned after the effects of irradiation have been suggested by Curtis & Healey (79), Jones (153), Landahl (194), Landahl & Hasegawa (196), Szilard (327), and others. Szilard (327) begins his model

with an organism which has, to a variable degree, built-in defect, initial genetic damage, to which are added the consequences of random environmental insults which cumulate to a lethal level. Landahl (194) has discussed the features of such models, which are essentially patterned after irradiation effects. Small amounts of irradiation seem to accelerate the normal causes of death, rather than produce a special lesion. The heuristic value of irradiation analogies to aging remains to be shown.

The random insult model of aging leaves unexplained the accumulated and transmitted effects of parental age upon longevity of offspring in the same species (198, 236). The older the parents, the shorter lived the offspring; in some species, inbred lines from early offspring become progressively longer lived whereas inbred lines from late offspring become progressively shorter lived. Explanations of aging based upon a probabilistic or irradiation model are seemingly confounded by the studies of Clarke & Smith (63), and also by Smith (311), on the effects of temperature on the longevity of *Drosophila*. These results suggest that there are different processes responsible for mortality at high and low temperatures. His review of genetic variations in aging (312) raises an interesting possibility about early-life selection with late-life consequences. "It is therefore probable that the deleterious effects of high blood pressure in old age are counterbalanced by advantages, perhaps earlier in life, natural selection maintaining the mean arterial pressure in the population at an optimal value." If extended, this view would make aging and late-life characteristics a consequence of the specialization of the young animal and would suggest the question of whether rapid or slow developers of the same species are favored in terms of late-life characteristics. There is also a question of whether short-lived individuals tend to show a kind of psychological foreshortening, or whether their capacities and traits are truncated by death, which has a precipitous quality, rather than characterized by a long series of antecedent changes which have general consequences for the entire organism. This leads to the further unanswered question of whether there are contingencies among biological processes in the latter part of the life span. There is considerable difficulty in conceptualizing and defining operationally biological, psychological and social aging. It remains a problem for research to demonstrate the extent of common processes of change in the various determinants of behavior in aging man.

Theory in the psychology of aging will gain much by attending to the developments in what might be called the general biology of aging (71, 111, 194, 198, 236, 288, 328), the area of genetics (156 to 159), and the place of time as a variable in the natural sciences (280), as well as the more specialized aspects of endocrine relations in aging (94). It would be a mistake, however, to assume that theory in the psychology of aging is exclusively dependent on general biology, for psychology also has its data and concepts to contribute to the pool of knowledge and explanation.

British psychological research on aging has to a greater extent than American been influenced by information theory (78, 122, 123, 368). It is

much too early to tell if this system of concepts, useful in building and understanding communication systems, will or will not easily lead to inferences and explanations of the natural phenomena of aging.

THEORY AND SOCIAL-CULTURAL INFLUENCES ON AGING

It should not be assumed from the preceding remarks that theory on the psychology of aging has been and should be exclusively influenced by general biology. Variables associated with social-cultural differences are known to influence many characteristics of aging, and theory, both in psychology and general biology, will have to provide explanations and hypotheses about some rather unfamiliar kinds of relationships. Von Mering's review (354) of the social-cultural background of the aging individual suggests that how long men live, in addition to how well they live in their later years, is to a great extent determined by environmental conditions. Although it is reasonable to accept the view that there is a genetic basis for the upper limit of the human life span, more important for the individual are environmental influences, and, indeed, at the present time it appears to be of greater significance to avoid overweight and smoking than to have long-lived parents (153, 312). To an increasing extent man lives in an environment which he builds and controls and the dramatic decline in man's muscle power, a source of energy (7), may have been of considerable importance in the improvement of mean life-expectancy in western countries. It is not easy to discern the diffuse effects on aging of a shortened work week and higher educational attainment and their interaction with the characteristics of organisms which have been selected for early-life vigor. Many things have happened which increase the adaptive capacity of the individual to survive, but it is also interesting to note the influences of the group in maintaining the aged individual (346). The single, widowed, and divorced occupy a disproportionate number of beds in hospitals and show poorer mortality rates (93, 153, 334), which probably reflects many influences, among them selection and variations in environmental supports. A monolithic biological theory is clearly not adequate to account for the data on aging in man: to an important extent, man's longevity and psychological characteristics are determined by environmental conditions and variables embedded in social-class differences. It would seem that most psychologists engaged in research on aging and theory construction must by necessity be both biological and social scientists.

HEALTH

Unlike samples of young adults or children, surveys of populations of older adults show a high proportion of disease conditions, some of which presumably would affect psychological processes (153, 323, 352, 354). Psychological research on aging has accordingly become increasingly concerned with issues of mental and physical health (190), an interest which is not limited to the diagnosis and care of individual older persons, but involves the study

of relations of psychological processes to the biological changes of aging and disease states (20, 56, 163).

The review by Jones (153) of age and human health shows considerable evidence of environmental influences on human mortality. The author distinguishes the health characteristics of the environment from the aging process. Many factors of interest to psychologists have been identified as associated with differences in the life span: marital status, smoking, urban-rural residence, and occupation. Jones makes an interesting comparison between two populations, "... the single, heavy-smoking male, sedentarily employed in a large U. S. city, may be compared with a married, non-smoking female living in rural Scandinavia. If all of these factors are assumed to be independent and additive, one would predict a difference in life expectancy of 20 to 35 years." He also presents evidence that college faculty members have a better mortality rate than heavy laborers. Such information has an important bearing on the interpretation of psychological measurements on selected populations in relation to such questions as whether the intellectually better endowed and educated are more resistant to later life decline. It is clearly not known if environmentally induced differences in health rather than initial endowment or education may be responsible for differential psychological changes in aging. Some indication of these relations might be obtained at present by cross-sectional psychological studies in countries with favored mortality, e.g., the Scandinavian countries, in comparison with populations having poor mortality rates. If the measured psychological characteristics of the populations are roughly the same, then, presumably, the differences in death rates have little to do with psychological variables. In contrast to illnesses, health is conceived of as a continuous variable which everyone has to some degree. One notable absence on the research scene is an operational definition of health, related to age. While the absence of an operational definition of health is not peculiar to research on aging, the need for one in this field is perhaps more acute.

The assessment of health status in older persons has several foci which touch upon psychological research. They include: (a) the measurement of precursor bodily states which are prodromal of pathology, e.g., of senile dementia, (b) the differentiation of individuals' attitudes toward their health from externally observed and measured health, (c) prediction of sudden incapacitation or the probability of operator failure, as in accidents, (d) detection of unusual health conditions in subjects which interfere with their normal psychological processes.

Many directional relationships in aging are unclear: thus, poor health might lead to retirement and retirement might lead to ill health (although research indicates that the latter is not as common a relation as the former (320, 331, 333). Also, good adjustment may lead to greater social activity as well as to greater activity facilitating adjustment.

The precision of current research does not yet permit statements about the extent to which attitudes and personal adjustment may influence the probability of survival (184). While good mental health may be facilitative

of current individual productivity, its influence on the life span is yet undefined except insofar as the two appear together in a social class matrix of many variables. The precise circumstance which terminates the life span is always to some extent accidental and may thus be unrelated to behavioral or psychological variables; the vulnerability to the accidental event has unknown psychological correlates. It is to be expected that, because of the covariation of mortality, social class, education, intelligence, and other variables, one could find a correlation in the population between longevity and intelligence. Yet such correlation would likely be inflated from our usual points of view. Specification of the relations between health, attitudes, activity, and psychological capacities will ultimately depend upon longitudinal study in order to separate the antecedents. Cross-section studies, however, are helping to refine the questions to be asked about the relations of biological, psychological, and social age.

THE NERVOUS SYSTEM

Some of the differences in behavior of old and young organisms very likely have their bases in endogenous biological changes in the nervous system. One may choose to be impressed with the fact that, in some instances, behavioral changes of advancing age may be related to alterations in the nervous system, or one may be impressed with the many changes which occur in the nervous system without any apparent consequence for behavior. A great variety of anatomical changes in the nervous system have been described with advancing age, ranging from the macroscopic to the submicroscopic level, where the electron microscope is necessary to describe structural alterations (8, 20, 28, 44, 49, 52, 58, 95, 130, 239). Most of the structural changes are without explained functional correlates, and the Conference on the Process of Aging in the Nervous System (20) made it apparent that psychological research is needed to supply the criteria of significance of the anatomical changes. Brain-behavior relations in aging are not obvious. They involve such characteristics of behavior as the simplicity or complexity of the task, recency of learning, redundancy, and the importance of speed or timing. The anatomical changes are subtle in the sense that the early changes are obscure and their antecedents not obvious. A young person would probably never be able to acquire the complex skills which an older person maintains despite diffuse and marked alterations in the structures of the nervous system. The duration of the change and rapidity of onset must play a role in addition to the site and nature of the process, giving rise to what may superficially appear as a lack of correlation between behavioral and neuro-anatomical changes. At present, there are no methods to reproduce experimentally in animals the changes of the nervous system associated with advancing age. One possibility often mentioned is radiation damage, but the nervous system appears to be selectively spared and the animals may die of other organ damage before the nervous system is significantly involved (196).

Past emphases on the nervous system in phenomena of aging have cast it as a recipient of extrinsic influences such as interference with blood flow or

hormone levels, whereas the contemporary emphasis is more on its intrinsic mechanisms of aging (20, 52, 138, 201). Less frequently mentioned is vascular impairment as the dominant antecedent change for brain and behavioral deterioration in later life, since marked alterations in the brains of man and animals may occur without obvious vascular change.

Psychomotor responses of aged persons frequently show diminished strength, slowness, and lessened capacity to modulate or integrate complex movements. These are graded changes, ones of degree, and are not gross matters of presence or absence of function, as might be associated with frank pathology leading to interruption of neural pathways. There is also some evidence that conditioned reflexes change with age in man and animals (40, 96).

Questions have been raised about the validity of inferences about aging based upon data obtained from hospital patients (20, 28), and more investigators will be turning to animals to obtain controlled material free, or relatively free, from disease and postmortem artifacts. Recently, age changes in the spinal cord of man (239) and dog [Frankhauser (95)] have been reported. The comprehensive monograph by Morrison on the human spinal cord represents an attempt to establish a control sample of normal data for judgments about late-life pathology, although it still contains influences of an uncertain mixture of aging and pathology. There are probably more than one process of aging and a variety of structures involved at several levels of the nervous system.

NEUROPHYSIOLOGICAL FACTORS

Neurophysiological studies of the brain have been almost exclusively electroencephalographic. With old age, an increase is noted in the number of EEG records with abnormal features as well as changes in basic parameters (55, 109, 247, 249, 305). Interest lies in relating the atypical features of the EEG in aging patients to psychiatric disturbances (217, 248, 249, 267), cerebral atrophy (9), senile deterioration (226), vascular disease (250), and the general level of psychological functioning (10, 55, 306, 330). In view of the general agreement that with advanced age there is a greater prevalence of abnormal features and shifts in basic wave characteristics, it seems likely that there will be interest in the next few years in longitudinal studies of the EEG in older persons in relation to concomitant disease states and cognitive and affective changes. While much of the interest in the EEG and age necessarily lies in identifying diagnostic and prognostic features for patient care, research is also called for on the factors which are responsible for the shifts in the EEG in otherwise normal older persons as well as in those with disease states. The intensity of electric shock convulsions was reported to diminish with age, particularly in men (139), and was interpreted as an indication of lower cerebral excitability. There are almost no studies on the effects of pharmacological agents on modifying responses in older organisms (174). In view of earlier suggestions that conduction velocity might be involved, Birren

& Wall (22) studied the conduction velocity of excised sciatic nerves from rats of different ages. Isolated nerves were obtained from about 75 rats ranging in age from 50 to 850 days. Results showed that conduction velocity increased during development from about 31 m.sec. at 60 days to 59 m.sec. at 350 days. After the developmental phase, conduction velocity did not change significantly. The authors concluded, on the basis of these and other results, that changes in peripheral nerves do not appear to be important in the changes in simple reaction time which occur during development and later life. Wayner & Emmers (362) studied spinal synaptic delay in young and old rats: 117-, 276-, 445-, and 822-day-old-rats. The respective mean synaptic delays (monosynaptic flexor hallucis longus reflex) were 0.97, 1.14, 1.23, and 1.36 msec. In agreement with the previous study (22), the authors found essentially no change in afferent conduction velocity, but did find that ventral root velocity declined from 64.2 m.sec. in the youngest to 43.7 m.sec. in the aged rats.

Clinicians have often mentioned what appears to be a diminished pupillary response with age, but the interpretation is not simple, since the older pupil tends to be smaller. Thus the latency of response and the rate of response viewed in relation to initial size may not be changed. Kumnick (188) did not find an age change in latency of pupillary constriction to light. Magladery (218) and Weiss (365), however, call for more detailed recording of latencies before this result is accepted.

Madonick (216) reported on the presence and absence of cutaneous abdominal reflexes in a group of 2500 nonneurological hospital admissions and in a group of 1000 psychoneurotic patients. There was a higher frequency of absent reflexes in the older patients, but in only 21 per cent of cases with absent reflexes was there other evidence of neurological involvement. Precisely what the greater frequency of absent reflexes implies for aging is not clear from this study. The author concludes: "Absence of the cutaneous abdominal reflex in itself is not an indication of nervous system disease" (216, p. 464).

Magladery, Teasdall & Norris (219) reported a provocative study on age changes in speed of cutaneous reflexes: plantar, flexor, and superficial abdominal. The latencies were all significantly longer in the older group: in 14 adults aged 26 to 46 years, the mean latency of the plantar reflex was 203 msec., whereas in a group of 15 individuals aged 61 to 85 years, the mean latency was 279 msec. The corresponding latencies for voluntary flexion were 170 msec. and 189 msec. Superficial abdominal reflexes, when present in the older subjects, had longer latencies than young adults; "... the average of these values is far beyond that obtained in normal young adults by a matter of 100 or more milliseconds" (219, p. 285). These findings corroborate the belief that the longer latencies of response in older persons is primarily a function of the central nervous system. Magladery *et al.* go further, concluding, "It is suggested that these reflex delays in aged persons are due, not to alterations in basic reflex mechanisms themselves, but to decreased excitatory influences on them from higher levels" (219, p. 287). This interpretation

is in agreement with that of Birren (20, 24) and Birren & Wall (21) that slowing of response speed with advancing age is intrinsic to many kinds of behavior and, thus, of considerable interest to psychologists. Although speed of reaction in children and young adults may be without much general significance for individual differences in behavior, the point is that the locus, nature, and significance of the increase in speed of response with advancing age, may represent a significant area of research for both psychological and neurophysiological investigations. At present, it is unknown whether the slowing is a consequence of a single mechanism with a precise anatomical locus or whether it represents diffuse multifaceted changes having in common only the fact of their simultaneous occurrence in the central nervous system of the same individual.

Weiss (365) studied the *a*-wave of the electroretinogram in old and young subjects and found no significant age differences in *a*-wave latency, peak times, or peak amplitudes. He used healthy male subjects, 10 young, 18 to 37 years, and 15 old, 66 to 76 years.

Pestalozza *et al.* (269) studied auditory electrophysiological phenomena in old guinea pigs. In a comparison of age changes in cochlear microphonic potentials, nerve action potentials, and summating potentials, the nerve action potentials changed most with age, and cochlear microphonic potentials least.

SENSORY FUNCTIONS

In terms of number of publications, one of the best developed areas of research on aging is the study of sensory functions. It is, however, one of the most scattered literatures, due, in large part, to the many different professional groups publishing studies in journals of their professional affiliation. Weiss (365) has presented a comprehensive review of the literature in the anatomical and functional aspects of sensory receptors which includes many useful foreign references not generally cited. Sensory limitations of all types are found with increasing frequency in older persons; blindness (17) and deafness (18) are those about which most is known, although limitations in other sensory modalities also occur with increasing frequency in the later years (51). Changes can be specific to a sense organ, as in cataract formation in the lens of the eye, and each sensory receptor likely has some particular phenomena associated with age changes in the specialized anatomical structures surrounding the sensory end organ. In addition to increases with age in such anatomical changes, which result in physical interference with receptor stimulation, there are problems of determining the integrity of both the peripheral and central neural structures necessary for sensation.

Vision.—Changes in pupil size with age and the prevalence of lens changes affect many measurements of visual function (131, 181, 365). Changes in amplitude of accommodation have long been known to occur in the aging eye; more recently, however, interest has been shown in the rate of accommodation. In a comparison of young and middle aged subjects, Allen

(4) found that accommodation time was slower in the older group. An attempt to study age changes in accommodation time with electrical stimulation of the ciliary ganglion was made by Marg & Reeves (224), using a 15-year-old cat. In this animal, "The accommodation amplitude of the aged cat was lower than that of the average young cat but not significantly so."

Kumnick reported a series of studies of age changes in the response of the pupil to light and dark (185, 187). She also studied the effects of fatigue in repeated response of the pupil and the restitution of the fatigued response by means of additional sensory stimulation, in this case, auditory (186, 188, 189). She was in agreement with previous studies that in human subjects the older pupil tends to be smaller, but, in proportion to its initial size, shows little change in the relative control over the amount of light entering the eye. The velocity of pupil constriction was found to decrease with age, although latency of constriction in the rested state did not show much change. Restitution of the fatigued pupil to a sudden loud noise did appear to be affected by age differences.

The age change in pupil size and elevation of thresholds is reflected in the distinct benefit older persons derive from increases in general level of illumination (326). Studies of Guth *et al.* (128, 129) show that older persons require higher levels of illumination to reach the same visibility as young subjects. Older subjects, however, required a greater absolute increase in illumination to achieve a comparable increment in visibility; this, in a general way, is comparable to the findings of Coppinger for critical flicker frequency (CFF). Coppinger (74) found that, with increasing brightness, the age difference in CFF increased rather than decreased; this would have been the case if the initial brightness threshold were the only relevant variable. Hence, while subjects may be equated for initial threshold, as in the case of brightness, not all of the changes in visual sensitivity seem to be explained by physical interference with the stimulus.

Significant age changes in visual sensitivity continued to be demonstrated in the dark-adapted eye (13, 292), even with the use of an artificial pupil (230). While the change with age in the rate of adaptation seems nonexistent or small, a large age difference in brightness threshold exists at all stages of adaptation. What may seem to be, in the older individual, a slower rate of adaptation in daily life situations may actually be the length of time necessary to reach an appropriate threshold level rather than a consequence of the rate of change in approach to the required level.

Gilbert (114) gave a color-matching test to 355 subjects between the ages of 10 and 93 years and found scores tended to be highest in the 20s, with significant decline thereafter. Shades of blue and green were more difficult to discriminate than those of red and yellow. Some earlier studies showed little change in color vision with age, indicating that further study is needed to define the conditions which minimize and maximize the tendency for a deficiency in color vision to appear in older populations.

Weiss (365) reviewed the small amount of data available on age changes

in the sensitivity of the human eye to electrical stimulation. What evidence exists suggests that the "electrical sensitivity" of the eye decreases after 25 to 29 years, producing a curve somewhat similar to the curves of the light threshold of the dark-adapted eye.

Defects in the eye and the visual system are to some extent additive in function, with the result that visual acuity, as a complex process, commonly changes with age. More recently, there has been interest in determining the difference limens for visual stimuli and comparing the Weber ratios for old and young subjects (41).

Audition.—The early literature leaves little doubt of the fact that with increasing age there is a loss in sensitivity to high frequency tones (365). The loss of sensitivity and the differential loss for high tones appears in both air-conduction and bone-conduction measurements (178, 254, 290). Adjustment to hearing aids may be a problem for some older persons in whom speech perception is poor (172). Attempts have been made, on one hand, to relate findings on pure tone thresholds to speech perception and, on the other hand, to anatomical evidence of loss of fibers in the human auditory nerve and a decrease in ganglion cells in the basal turn of the cochlea (365). Schuknecht (293) in his studies of cats, found a correspondence between audiometric changes and "epithelial atrophy" in the cochlea and "neural atrophy." The studies by Pestalozza *et al.* (269) on bioelectric potentials of ears of senile guinea pigs found a lowering of response, most marked for the high frequencies.

Vestibular functions.—While dizziness has been frequently mentioned as a complaint of later life (256, 257, 258), the role of the vestibular apparatus, if any, in the sensation of dizziness and proneness to falling is not apparent. Data available from rotation tests and caloric tests suggest that vestibular sensitivity and associated response are not much changed up to 50 years, at least (182, 365). It is possible that the threshold of the vestibular apparatus to stimulation may be minimally affected with age (although threshold measurements per se have not been reported), with subjective reactions changing with age, since methods for vestibular stimulation may be somewhat unfamiliar and unpleasant.

Taste and olfaction.—Evidence from earlier anatomical studies shows a loss in the number of taste buds with advancing age (2, 365). One recent study by Bourliere *et al.* of taste perception reports a differential reduction in taste sensitivity with age (39). Solutions containing different concentrations of salt or sucrose were presented to old and young men and women ($N=81$) in comparison with distilled water. For sugar, the "... thresholds of perception and recognition are much higher in old subjects. . . ." The "perception" of salt was not found to change with age, although older men were found to have a high "recognition" threshold. Cooper, Bilash & Zubek (73) also reported decline in taste sensitivity with age, based upon results obtained from 100 subjects aged 15 to 89 years. However, this study differed from the earlier one (39) in that it found no sex differences or differences in

the amount of change in detection of sweet, sour, salty, and bitter stimuli. No recent studies of olfactory sensitivity have been reported, although anatomical evidence (208, 365) suggests that loss of sensitivity should be found in some individuals.

Vibration.—Earlier clinical studies of vibration sensitivity and age, using tuning forks, have been substantiated with more reliable methods (136, 365). With age, a diminution of sensitivity is found, and, also, a gradient such that the big toe shows more loss than the index finger.

Problems of Sensory Studies.—Much of the data of sensory changes in older persons is secured from clinic populations; major complaints which bring individuals to clinics may, to some unknown degree, be related to the function measured and reported on. Also, interest is concentrated on vision and hearing in which areas defects are usually of greater concern to the patient than changes in, e. g., touch, pain, taste, and smell. Because of the relatively greater sophistication of method and available literature, psychological research on aging has placed a heavy emphasis on vision and hearing. Pain is one of the neglected areas of study (300). With attention to the development of laboratory methods of sensory measurements in the unexplored areas and the study of more normal aged persons, it seems very likely that research on aging will make some fundamental contributions to the general understanding of sensory and perceptual processes.

SPEECH

Mysak & Hanley (242) found a trend in men's speech toward lowering of mean pitch level from early life to middle age, and then a progressive rising toward the later years. The authors also reported a trend toward a lower vocal rate with age in the adult years. Another provocative study was that of Shames & Beams (295), who made a survey of stuttering in a sample of 11,257 children and adults. Their results showed "... a definite downward trend in the number of stutterers seen in the older age groups. . . ." Speech modifications with advancing age, such as a decline in stuttering, do not appear to be readily explained as an adaptation to changes in hearing, although some correlative data on this point would be useful. Speech changes with age may, of course, be reflecting influences similar to those involved in most complex skills, e.g., a slowing of latency.

COMPLEX PERCEPTUAL PROCESSES

While research on aging has had, and will likely continue to have, an active concern with elementary sensory processes, in recent years special attention has been given to studies of complex stimuli requiring graded responses. It seems appropriate, somehow, that the psychology of aging gives relatively more emphasis to research on achievement and complex skills than upon learning, which is of major concern in early development.

A specialized literature has already been built up in the psychology of aging surrounding the problem of specifying the nature of the changes in the

capacities of the individual by means of studies of speed and accuracy of response in relation to stimuli of experimentally varied complexity and difficulty. The detailed reviews by Braun (41) and Weiss (365) indicate that the input to the older organism is restricted in a variety of ways, so that for most stimuli the older person is basing his judgments on a less "intense" stimulus. It is not unexpected, then, that there is a body of literature showing restricted output or responses from older subjects (11, 23, 24, 33, 35, 36, 66, 67, 78, 122, 126, 170, 264, 265, 266, 284, 368). While there is sufficient evidence to suggest that stimulus intensity is not the major, or at least the exclusive, variable (30, 38, 41, 74, 195), it seems likely that perceptual judgments are based upon a restricted range of variation (a higher threshold and a lower maximum with consequent fewer just noticeable differences). Complicating the picture is the general tendency for slower responses in the older individual, which seems to be established as predominantly a characteristic of the central nervous system (22, 23, 25, 27, 218, 362). More than one "central" component may be involved, such as set, motivation, and context conditions (29, 32, 33, 37, 121, 122, 123, 325). Different results are thus obtained, depending upon whether one uses speed of response or accuracy of response in relation to stimulus differences (e.g., 195).

The interrelations of critical flicker frequency (CFF), age, and intelligence were studied by Landis & Hamwi (197). Their data confirm the negative correlation of CFF and age, but do not confirm previous claims (70) of a CFF and intelligence correlation. It would not be surprising, however, if nonverbal tests with a heavy visual-perceptual component would show some correlation with CFF and age.

It has been found in a number of studies that varying a stimulus magnitude to be judged, such as a weight difference, a difference between two line lengths, or judgments of several simultaneously varied properties, does not fully explain the age difference in response tendencies (11, 23, 33, 35, 38, 64, 66, 67, 180, 196, 275, 355). Many investigators appear to accept the fact that older persons tend to respond with a longer latency. These investigators have become interested in what other general response characteristics are displayed, such as a conservative tendency in making judgments when stimuli become uncertain or ambiguous. There do appear to be differences with age, which, under certain experimental conditions, appear related to set, level of confidence, tendency to preoccupation with concrete details of complex stimuli, and perseveration. The recency of much of these data, the fact that subjects have varied in nature, and the absence of any "cross modality" replications make generalizations premature.

Feifel (101) studied perception of elapsed time, found that older subjects tended to underestimate time intervals (30 to 300 sec.) more than did young subjects. Whether judgments of small amounts of elapsed time are related to longer time-perspective, which might be influenced by institutionalization, is not clear (103). Attitudes toward the future or concern with the past may be less a matter of capacity of perceiving elapsed time as it is a matter of activity and personal adjustment (92, 102).

PSYCHOMOTOR SKILLS

There is the task of deciding whether, in complex behavior or skills, an age difference primarily results from a deficit in information transduced from environmental stimuli, a failure to recognize that which is reasonably well available, a deficit in selecting an appropriate response, or a deficit in programming and effecting a response. Research on age changes in psychomotor skills has come to discriminate differences in movement time, time at decision points in sequential acts, modulation of ongoing behavior, and the residual effects of preceding responses in contrast to set and random fluctuations in response characteristics (24, 29, 32, 37, 42, 271, 308, 309, 366, 368). Differential changes in long- and short-term memory will have to be examined for their role in long- and short-term set maintenance and resistivity to distraction by task fragments. It is important to note that the degree to which the subject is permitted to vary the manner of task performance (in order to secure some prescribed output) will influence the extent to which age differences will appear. Compensation for acquired limitations may shift the approach or work method, so that the older persons reach the same end result, but by a somewhat different path (366, 368), and may show a greater dependence upon one sensory modality (325).

Differences in motivation have been mentioned in relation to age differences (6, 30, 89, 211, 367), but as yet there is no body of appreciable experimental literature to cite. Anecdotal accounts of experimenters give the impression that older subjects are more motivated to achieve a high-level output and are concerned with avoiding errors to a greater extent than young subjects.

LEARNING

The experimental literature on learning and age has been well organized and evaluated by Jerome (148). Kay (165) has described the implications of learning theory for aging and, conversely, of aging for learning theory. It is surprising how few learning theories have given attention to the age of the organism as a variable. The remarks of Jerome (148), Kay (165), and Welford (367) give the impression that the limited early literature is mostly useful in defining that which we need to know.

More recently, attention has been given to the suitability of methods, as well as the equating of materials, in studies of learning in young and old subjects (31, 40, 46, 115, 164, 179, 287, 375, 376). Problems of skill acquisition, retention, and modification have important implications for industrial jobs, and studies are appearing about learning in work contexts (168, 302). Also, studies of learning, age, and psychiatric states are appearing (145, 286) in an effort to understand the bases of maladaptive adult behavior.

One of the basic problems emerging is the validity of distinguishing in studies of aging the processes of acquisition from those of extinction in learning. The question is whether there is a differential change with age in the capacity to learn vs. the capacity to unlearn, extinguish, or otherwise modify a response already learned. While earlier literature stressed the priority of

established habits in the aged, it is by no means settled that the older organism has more difficulty in modifying established responses than in acquiring new noninterfering responses. It is a practical problem to maintain animals (even rats) for long-term study (351) of learning. The effects of early experience, such as handling (112), are only known for their consequences for young adult behavior.

MENTAL ABILITIES

One of the earliest concerns of research on aging was with questions of differential change in mental abilities. This remains one of the most active research areas, although it would be difficult to secure agreement on answers to some of the original questions raised 25 years ago (211, 273). Jones' 1959 review of the literature (152) contains an impressive amount of quantitative information, although too few longitudinal studies exist with broad ranges of subjects and types of functions measured. Whether "intelligence" goes up, stays the same, or declines with age apparently depends upon the kinds of subjects and types of tests. Furthermore, not much progress has been made in defining what intelligence is for older persons or what might comprise a criterion. Many investigators are implicitly carrying forward a criterion of "something like scholastic success," although some are studying test performance in relation to physical status and other types of independent assessment.

Studies of aging of identical twins are now being reported which portend some changes in our concepts about aging (146, 147, 156, 158). Differences between one-egg twins for age at death and for mental test scores are significantly less than differences in fraternal twins or siblings. These results indicate the necessity of interpreting environmental influences, such as those reflected in social class and differences in education, within some biological context.

The relation of age to top-level achievement has aroused interest (14, 45, 83, 84, 85, 87, 223, 237, 238, 263), although some contention has arisen (86, 202). Lehman's earlier monumental analysis of age and creativity was criticized by Dennis (86) and rejoined by Lehman (202), with issues revolving about the kinds of inferences which can be drawn from available data about the relationship of age to rate of production (creative) and maximum production. While the reasons remain unsettled, creative output in our society has been related to chronological age. A question has been raised whether those individuals with high initial ability do not have a more favorable age curve (113, 152, 314). The special education, occupational selection, and social influences to which the top-ability persons are exposed would make it surprising if they did not show some uniqueness in their age-ability curves. Sampling and other problems remain to be settled before such data are interpreted in any detail (113).

Kaplan reviewed the data on the aged subnormal (162), while McCulloch reported a recent study of changes of mental ability with age in retarded

persons (227). This paper broadens the issues considerably, for it reported test-retest data on retarded institutionalized individuals over the age of 16 years, using the 1937 Stanford-Binet. Results indicated a rise in scores in the 20s and "... a decline in the later years which is statistically significant only at 55 to 60 years."

Differential changes in ability with age continued to be reported. There has been a notable increase in the variety of tests used and the sophistication of methods of analysis, hypotheses, and interpretations (47, 68, 69, 82, 88, 91, 110, 116, 141, 149, 151, 160, 191, 205, 206, 221, 222, 245, 246, 281, 282, 291, 313, 324, 371). Few attempts have yet been made to manipulate the age-related variables with ability measures as the dependent variable. One of the exceptions was Caldwell's report on sex hormone replacement in aged women (59).

Because of the fact that about one per cent of the population over the age of 65 is institutionalized for mental illness (334), together with an increasing older population (298) and urbanization (77), it is not surprising that there is interest in devising methods of evaluating mental functioning in elderly adults (56, 57, 140, 142, 144, 145, 146, 161, 225, 259, 260, 297, 359, 360, 363, 364, 377). The separation of processes of later-life mental disease from aging is not at all clear, with the exception of the accelerated forms of brain disease (54). The improvement of cognitive and affective measurement may reveal some subpopulations whose time course of mental change is sufficiently unique to justify regarding them as a reflection of separate syndromes (372 to 374). Not all mental diseases of later life are associated with mental deficit, and transient affective states are observed (54, 60, 373). A somewhat specialized body of literature is accumulating on psychiatric problems of later life, which involve psychological evaluation (72, 75, 76, 183, 193, 261, 274, 361, 372). Kolb analyzed statistics on mental hospitalization of the aged and concluded that sociological factors rather than mental disease lie behind the increases in admission rates (177). He suggests a need for a better epidemiological approach to mental illness in the aged (120).

PERSONALITY AND ADJUSTMENT

The literature on personality measurement, often concerned with distinctions between "organic" and "functional" states in the aged, is not as yet as well developed, but it has shown some increase (1, 50, 137, 192, 207, 212, 244, 253, 277, 353, 358). A previous review pointed out that older persons must adapt to many later life demands, e.g., retirement, death of family members and friends, and changes in standards and styles of living (26). These important changes, largely initiated by forces outside the individual's control, must be negotiated by an organism which itself is changing. The level of drive and activity may decline with age in both humans (7, 34) and animals (199, 200). Such changes are not often taken into account in describing personality changes, as a consequence of the lack of attention given

to the last half of the life span by personality theorists. Riegel (285) reviewed personality theory and aging, finding that contemporary personality theory has given little or no attention to postmaturational changes. Kuhlen (184) reviewed the literature on adjustment, and calls for a life-span developmental psychology. Hopefully, a psychobiological orientation will develop which will give proper recognition to the cognitive, conative, and affective aspects of the individual.

A considerable amount of literature is available indicating that attitudes change with age and that there exists a body of attitudes or beliefs about older persons which the aged themselves may share (97, 104, 117, 176, 213, 252, 317, 336, 337, 338, 340, 341, 342, 344). The perception of age differences may change with age (61, 318), and preferences may exist for certain facial proportions which change with age (329). Processes of making judgments may change with age, and differently for the sexes (356, 357).

Chronological age may be predicted with considerable accuracy from appearance alone (243); awareness of age, as readily revealed by appearance, probably evokes many stereotyped forms of social behavior. Individual differences in social roles appear to determine many features of adjustment in the middle and late years (15, 43, 62, 80, 81, 132, 133, 134, 244, 268, 270, 289). Empirically, there appears to be a relation between the number of social roles and adjustment. Activity (132) and increased interpersonal contact may be prophylactic for many problems of later life, such as depression, but there are always the issues of separating the consequences of the experience per se from the pre-existing personality characteristics of the individuals (299). Similarly, while a given older individual may appear to share a stereotyped view of the age group of which he is a member, he may be expressing a realistic appraisal of his unique set of experiences.

Ill health in an older person may have marked effects upon attitudes (154, 214, 343), just as pre-existing personality characteristics may affect adjustment to illness with individuals, either maximizing or minimizing their symptoms and discomfort.

Illness and advanced age confront the individual with a likelihood of death, which may challenge his attitudes in an unanticipated manner. Feifel has reported several studies on attitudes toward death which open this relatively repressed topic for discussion (98, 99, 100), and Shrout (304) has related attitudes toward death to type of institutional residence. Feifel holds that individual concepts of death can act as an important organizing principle in behavior throughout the life span. Whether life adjustment and attitudes toward "life" have implicit in them counterpart attitudes toward death is not obvious. Reactions to confrontation with intimate details of death is of special concern in institutions for the aged (304). This and more general problems of attitudes and adjustment of the aged in institutions will continue to grow in significance as interest rises in improving living arrangements (105, 119, 173, 175, 204, 294, 303, 361).

Institutionalization is not the only change in living arrangements which

requires adaptation on the part of aged persons. Family patterns can change markedly as children grow up and leave home (335), or as the generations continue to live under the same roof (315), or as the wage earner retires (319). Questions have been raised about the stability of the personality through all the changes in all the outer aspects of life during the adult years. With the exception of Kelly's (166) follow-up of young adults, almost nothing is known. Such information about the stability of adult characteristics will be valuable background information for psychotherapeutic measures reviewed in detail elsewhere (118, 127, 279).

One of the special problems of the aged requiring attention is the high incidence of suicides. The relatively high suicide rates belie the notion that old age is a period of tranquility for many persons at least. The 1925 suicide rate for persons 35 to 44 years was 18.0 (per 100,000) and in 1953, 12.6; for persons 65 to 74, the 1925 rate was 35.8 and in 1953, it was 26.0 (348, Table 2). Old males had a suicide rate almost six times as great as females. Tuckman (345) and others (12, 255) have called for methods of predicting and managing potential suicides.

RETIREMENT

Retirement has been a much discussed issue with many implications going far beyond the psychology of aging, e.g., size of labor force and comparative economics of retirement systems. Recent studies of Streib & Thompson (320, 321, 322, 331, 332, 333) suggest that perhaps the psychological consequences of retirement have been overly emphasized. For special groups, retirement may represent a large problem, although sometimes only indirectly psychological (3, 53, 209, 215, 233, 234, 296). For some occupations, the primary interest of the worker is in the income, the work itself being of low prestige and perhaps not very pleasant; by contrast, professional persons often find their work pleasurable in addition to being a source of income, and they would correspondingly react differently to the thought of retirement (90, 339). Of growing importance is the need for preretirement counselling. Freeman (106, 107, 108) has recently prepared several tests for gathering facts of use in retirement counselling.

WORK

Related to the topic of retirement are questions of work capacity of older persons. Whether or not society, or its individuals, wishes to continue employment in the later years, there is the objective matter of describing skills, work capacities, and attitudes toward work, as a function of age. One of the ways to gain clues to the nature of older workers is to study the drift of older workers into jobs of their choice; presumably the age-job structures of some industries will reflect selective pressures (125, 240, 241, 347). In some jobs, time pressure or pacing may be of greater significance than heavy work (16, 48). In modern industry, age changes in speed and timing may be of greater consequence than reduced strength or other capacities (228, 272, 307, 368).

There is the special problem of transportation employees wherein an operator failure may be of such public consequence that even a very low probability of an error of judgment or sudden incapacitation has to be taken seriously. McFarland has reviewed (228 to 232) the evidence related to many types of transportation jobs. One of the more difficult points is that the more crucial the job the more infrequent the failures and more obscure is the criterion against which assessment measures can be validated (310). For some critical and specialized jobs, it may be necessary to decide by judgment what the age-related critical capacities are from information gained from accident records from workers in less critical tasks (124, 167) or perhaps from production records (65, 155, 169, 220). In some situations, job characteristics and workers' production capacity may be of less significance than attitudes toward the work and work context (171, 235, 316). Still another area which has become of interest to psychologists is the identification of jobs which are particularly well suited for older workers (203, 276).

CONCLUSIONS

Events seem to forecast the emergence of a well-grounded developmental psychology of the total life span, although research on aging will by necessity differ in content and methods from research on child development. It is beginning to be possible to discriminate between studies which are secondarily or remotely related to aging and those which deal with core issues. The mere inclusion of age as a variable does not make a study one of aging. An essential feature appears to be an interest on the part of the investigator in understanding and explaining systematic changes which occur with advancing age in adult organisms.

Many of the psychological changes of aging are of sufficient public interest that psychologists will be under increasing pressure to refine their methods so that sampling errors can be specified as well as the nature of the population studied. Psychological tests will have to be better standardized on older populations. The drift toward higher education and improved health in older groups will undoubtedly result in secular trends in the characteristics of older persons. The average persons aged 65 today will be different from the same group several decades from now. Both longitudinal and cross-sectional studies will be faced with the need for repeated samples in order to check on secular trends, and perhaps more data will be presented by cohort groups in future studies. The longitudinal method, despite practical problems, is the ideal method for studying age changes (150); cross-sectional studies are a compromise in order to obtain approximate results more quickly. Similarly, experimental animals of unknown background will begin to be replaced by animals reared under constant conditions.

Because of the increased interest in the psychology of aging in other countries (135, 262, 283, 284, 301, 349, 350, 369, 370), cross-cultural comparisons might be undertaken. Similarities and differences in the characteristics of age groups in different countries will help to distinguish extrinsic and intrinsic factors of aging.

More research appears destined to be done in collaborative settings with scientists from other biological and social sciences. This results both from the complexity of the problems and from the necessity of centralized facilities, since the conduct of the research, as well as the problems of securing and maintaining samples of older persons, are usually too great for one investigator.

LITERATURE CITED

1. Aaronson, B. S. Age and sex influences on MMPI profile peak distributions in an abnormal population. *J. Consulting Psychol.*, **22**, 203-6 (1958)
2. Allara, E. Investigations on the human taste organ. I. The structure of taste papillae at various ages. *Arch. ital. anat. embriol.*, **42**, 506-64 (1939)
3. Alleger, D. E. The role of agriculture in retirement: a study in five Florida counties. *Rural Sociol.*, **20**, 124-31 (1955)
4. Allen, M. J. The influence of age on the speed of accommodation. *Am. J. Optometry*, **33**, 201-8 (1956)
5. Anderson, J. E. A development model for aging. *Vita Humana*, **1**, 1-18 (1958)
6. Anderson, J. E. (Ed.). *Psychological Aspects of Aging* (American Psychological Association, Washington, D. C., 323 pp., 1956)
7. Anderson, J. E. The use of time and energy. In *Handbook of Aging and the Individual: Psychological and Biological Aspects*, Chap. 22 (Birren, J. E., Ed., University of Chicago Press, Chicago, Ill., 1959)
8. Andrew, W. Structural alterations with aging in the nervous system. *J. Chronic Diseases*, **3**, 575-96 (1956)
9. Balestrieri, A., Greenstein, L., and Strauss, H. The electroencephalogram in cerebral atrophy. *Am. J. Med. Sci.*, **230**, 178-81 (1955)
10. Barnes, R. H., Busse, E. W., and Friedman, E. L. The psychological functioning of aged individuals with normal and abnormal electroencephalograms. *J. Nervous Mental Disease*, **124**, 585-93 (1956)
11. Basowitz, H., and Korchin, S. J. Age differences in the perception of closure. *J. Abnorm. Soc. Psychol.*, **54**, 93-97 (1957)
12. Batchelow, I. R. C. The management and prognosis of suicidal attempts in old age. In *Old Age in the Modern World. Proc. Intern. Assoc. Gerontol. 3rd Congr.*, 472-73 (London, England, 1954) (E. & S. Livingstone, Ltd., London, England, 656 pp., 1955)
13. Baumgartner, P., and Bernard, M. Sur la senescence de la vision nocturne. *Bulletin de l'academie nationale de medecine*, **142**, 85-91 (1958)
14. Bayley, N., and Oden, M. H. The maintenance of intellectual ability in gifted adults. *J. Gerontol.*, **10**, 91-107 (1955)
15. Beckman, R. O., Williams, C. O., and Fisher, G. C. Adjustment to life in later maturity. *Geriatrics*, **13**, 662-67 (1958)
16. Belbin, R. M. Older people and heavy work. *Brit. J. Ind. Med.*, **12**, 309-19 (1955)
17. Belloc, N. B. Blindness among the aged. *Public Health Repts. (U. S.)*, **71**, 1221-25 (1956)
18. Bentzen, O., and Jernes, K. Incidence of impaired hearing in Denmark. An evaluation based on the social condition of hearing for 5,000 individuals. *Acta. Oto-Laryngol.*, **45**, 189-97 (1955)
19. Birren, J. E. Principles of research on aging. In *Handbook of Aging and the*

- Individual: Psychological and Biological Aspects*, Chap. 1 (Birren, J. E., Ed., University of Chicago Press, Chicago, Ill., 1959)
20. Birren, J. E., Imus, H., and Windle, W. (Eds.). *The Process of Aging in the Nervous System* (Charles C Thomas, Publisher, Springfield, Ill., 224 pp., 1959)
 21. Birren, J. E., and Kay, H. Swimming speed of the albino rat: I. Age and sex differences. *J. Gerontol.*, **13**, 374-77 (1958)
 22. Birren, J. E., and Wall, P. D. Age changes in conduction velocity, refractory period, number of fibers, connective tissue space and blood vessels in sciatic nerve of rats. *J. Comp. Neurol.*, **104**, 1-16 (1956)
 23. Birren, J. E., and Botwinick, J. Speed of response as a function of perceptual difficulty and age. *J. Gerontol.*, **10**, 433-36 (1955)
 24. Birren, J. E. Age changes in speed of simple responses and perception and their significance for complex behavior. In *Old Age in the Modern World. Proc. Intern. Assoc. Gerontol.*, 3rd Congr., 235-47 (London, England, 1954) (E. & S. Livingstone Ltd., London, England, 656 pp., 1955)
 25. Birren, J. E. Age differences in startle reaction time of the rat to noise and electric shock. *J. Gerontol.*, **10**, 437-40 (1955)
 26. Birren, J. E. Aging and psychological adjustment. *Rev. Educ. Research*, **28**, 475-90 (1958)
 27. Birren, J. E., and Botwinick, J. Age differences in finger, jaw and foot reaction time to auditory stimuli. *J. Gerontol.*, **10**, 429-32 (1955)
 28. Bondareff, W. Morphology of the aging nervous system. In *Handbook of Aging and the Individual: Psychological and Biological Aspects*, Chap. 5 (Birren, J. E., Ed., University of Chicago Press, Chicago, Ill., 1959)
 29. Botwinick, J., Brinley, J. F., and Robbin, J. S. Modulation of speed of response with age. *J. Genet. Psychol.* (In press)
 30. Botwinick, J., Brinley, J. F., and Robbin, J. S. The effect of motivation by electrical shocks on reaction-time in relation to age. *Am. J. Psychol.*, **71**, 408-11 (1958)
 31. Botwinick, J., Jerome, E. A., Birren, J. E., and Brinley, J. F. Light aversion motivation in psychological studies of aging rats. *J. Gerontol.*, **12**, 296-99 (1957)
 32. Botwinick, J., Brinley, J. F., and Birren, J. E. Set in relation to age. *J. Gerontol.*, **12**, 300-5 (1957)
 33. Botwincik, J., Robbin, J. S., and Brinley, J. F. Reorganization of perception with age. *J. Gerontol.*, **14**, 85-88 (1959)
 34. Botwinick, J. Drives, expectancies, and emotions. In *Handbook of Aging and the Individual: Psychological and Biological Aspects*, Chap. 21 (Birren, J. E., Ed., University of Chicago Press, Chicago, Ill., 1959)
 35. Botwinick, J., Robbin, J. S., and Brinley, J. F. Age differences in card sorting performance in relation to task difficulty, task set and practice. *J. Exptl. Psychol.* (In press)
 36. Botwinick, J., Robbin, J. S., and Brinley, J. F. Modifying perceptions in relation to age. (Abstract) *Am. Psychologist*, **13**, 354 (1958)
 37. Botwinick, J., Brinley, J. F., and Robbin, J. S. Task alternation time in relation to problem difficulty and age. *J. Gerontol.*, **13**, 414-17 (1958)
 38. Botwinick, J., Brinley, J. F., and Robbin, J. S. The interaction effects of perceptual difficulty and stimulus exposure time on age differences in speed and accuracy of response. *Gerontologia*, **2**, 1-10 (1958)

39. Bourliere, F., Cendron, H., and Rapaport, A. Modification avec l'age des seuils gustatifs de perception et de reconnaissance aux saveurs salees et sucrees, chez l'homme. *Gerontologia*, **2**, 104-12 (1958)
40. Braun, H., and Geiselhart, R. Age differences in acquisition and extinction of the conditioned eyelid response. *J. Exptl. Psychol.*, **57**, 386-88 (1959)
41. Braun, H. W. Perceptual processes. In *Handbook of Aging and the Individual: Psychological and Biological Aspects*, Chap. 16 (Birren, J. E., Ed., University of Chicago Press, Chicago, Ill., 1959)
42. Brinley, J. R., and Botwinick, J. Preparation time and choice in relation to age differences in response speed. *J. Gerontol.*, **14**, 226-28 (1959)
43. Britton, J. H., and Mather, W. G. Assessments of adjustment of older adults. (Abstract) *Am. Psychologist*, **13**, 354 (1958)
44. Brody, H. Organization of the cerebral cortex. III. A study of aging in the human cerebral cortex. *J. Comp. Neurol.*, **102**, 511-56 (1955)
45. Bromley, D. B. Some effects of age on the quality of intellectual output. *J. Gerontol.*, **12**, 318-23 (1957)
46. Bromley, D. B. Some effects of age on short term learning and remembering. *J. Gerontol.*, **13**, 398-406 (1958)
47. Bromley, D. B. Primitive forms of response to the Matrices Test. *J. Mental Sci.*, **99**, 374-93 (1953)
48. Brown, R. A. Age and "paced" work. *Occupational Psychol.*, **31**, 11-20 (1957)
49. Brownson, R. H. Perineuronal satellite cells in the motor cortex of aging brains. *J. Neuropathol Exptl. Neurol.*, **15**, 190-95 (1956)
50. Brozek, J. Personality changes with age: an item analysis of the Minnesota Multiphasic Personality Inventory. *J. Gerontol.*, **10**, 194-206 (1955)
51. Brückner, R., Gsell, O., Hügin, F., Batschelet, E., and Verzar, F. Fortlaufende Erfassung des Alternsprozesses—Vergleichende Untersuchungen am Auge und anderen Organen. In *Experimentelle Altersforschung*, 279-82 (Verzar, F., Ed., Birkhäuser Verlag, Basel, Switzerland and Stuttgart, Germany, 1956)
52. Bürger, M. Das Altern des Zentralnervensystems. In *Experimentelle Altersforschung*, 101-11 (Verzar, F., Ed., Birkhäuser Verlag, Basel, Switzerland and Stuttgart, Germany, 1956)
53. Burges, E., Corey, L. G., Pineo, P. C., and Thornburg, R. T. Occupational differences in attitudes toward aging and retirement. *J. Gerontol.*, **13**, 203-6 (1958)
54. Busse, E. W. Psychopathology. In *Handbook of Aging and the Individual: Psychological and Biological Aspects*, Chap. 12 (Birren, J. E., Ed., University of Chicago Press, Chicago, Ill., 1959)
55. Busse, E. W., Barnes, R. H., Friedman, E. L., and Kelty, E. J. Psychological functioning of aged individuals with normal and abnormal electroencephalograms. I: A study of non-hospitalized community volunteers. *J. Nervous Mental Disease*, **124**, 135-41 (1956)
56. Busse, E. W., Barnes, R. H., Silverman, A. J., Thaler, M., and Frost, L. L. Studies in the process of aging. X: Strength and weaknesses of psychic functioning in aged. *Am. J. Psychiat.*, **111**, 896-901 (1955)
57. Busse, E. W., Barnes, R. H., Silverman, A. J., Shy, G. M., and Thaler, M. Studies in the process of aging: Factors which influence the psyche of elderly persons. *Am. J. Psychiat.*, **110**, 897-903 (1954)
58. Critchley, M. Neurologic changes in the aged. *J. Chronic Diseases*, **3**, 459-77 (1956)

59. Caldwell, B. McD. Psychologic correlates of sex hormone replacement in the aged: a critique. *J. Am. Geriat. Soc.*, **4**, 560-71 (1956)
60. Cameron, N. Neuroses of later maturity. In *Mental Disorders in Later Life*, 2nd ed., Chap. 8, 201-43 (Kaplan, O. J., Ed., Stanford University Press, Stanford, Calif., 508 pp., 1956)
61. Cawthorne, F. M., and Kogan, N. *The Differential Cue Value of Age and Occupation in Impression Formation* (Presented at the 30th Eastern Psychol. Assoc. Meetings, Atlantic City, N. J., April, 1959)
62. Chalfen, L. Leisure-time adjustment of the aged. II. Activities and interests and some factors influencing choice. *J. Genet. Psychol.*, **88**, 261-76 (1956)
63. Clarke, J. M., and Smith, J. M. The genetics and cytology of drosophila subobscura XI. Hybrid vigour and longevity. *J. Genet.*, **53**, 172-80 (1955)
64. Clay, H. M. Changes of performance with age on similar tasks of varying complexity. *Brit. J. Psychol.*, **45**, 7-13 (1954)
65. Clay, H. M. A study of performance in relation to age at two printing works. *J. Gerontol.*, **11**, 417-24 (1956)
66. Clay, H. M. The relationship between time, accuracy and age on similar tasks of varying complexity. *Gerontologia*, **1**, 41-49 (1957)
67. Clay, H. M. An age difficulty in separating spatially contiguous data. *J. Gerontol.*, **11**, 318-22 (1956)
68. Cohen, J. A factor-analytically based rationale for the Wechsler Adult Intelligence Scale. *J. Consulting Psychol.*, **21**, 451-57 (1957)
69. Cohen, J. The factorial structure of the WAIS between early adulthood and old age. *J. Consulting Psychol.*, **21**, 283-90 (1957)
70. Colgan, C. M. Critical flicker frequency, age, and intelligence. *Am. J. Psychol.*, **67**, 711-13 (1954)
71. Comfort, A. *The Biology of Senescence* (George Routledge & Kegan Paul, Ltd., London, England, 257 pp., 1956)
72. Conwell, D. V., Kurth, C. J., and Murphy, P. G. Use of psychologic tests in determining prognosis and treatment in geriatric mental illness. *J. Am. Geriat. Soc.*, **3**, 232-38 (1955)
73. Cooper, R. M., Bilash, I., and Zubek, J. P. The effect of age on taste sensitivity. *J. Gerontol.*, **14**, 56-58 (1959)
74. Coppinger, N. W. The relationship between critical flicker frequency and chronologic age for varying levels of stimulus brightness. *J. Gerontol.*, **10**, 48-52 (1955)
75. Cosin, L. Z., Mort, M., Post, F., Westropp, C., and Williams, M. Experimental treatment of persistent senile confusion. *Intern. J. Social Psychiat.*, **4**, 24-42 (1958)
76. Cosin, L. Z., Mort, M., Post, F., Westropp, C., and Williams, M. Persistent senile confusion: Study of 50 consecutive cases. *Intern. J. Social Psychiat.*, **3**, 195-202 (1957)
77. Cowgill, D. Trends in the ecology of the aged in American cities. *J. Gerontol.*, **12**, 75-80 (1957)
78. Crossman, E. R. F. W., and Szafran, J. Changes with age in the speed of information intake and discrimination. *Experimental Research on Aging, Experientia Suppl. IV*, Chap. 17, 128-35 (Verzar, F., Ed., Birkhäuser Verlag, Basel, Switzerland, 1956)
79. Curtis, H. J., and Healey, R. Effects of radiation on ageing. In *Advances in Radiobiology*, 261-65 (Oliver & Boyd, Ltd., Edinburgh, Scotland, 1958)

80. Dailey, C. A. The natural structure of the life history. *Vita Humana*, 2, 11-24 (1959)
81. Dean, L. R., Cumming, E., and Newell, D. S. *Interaction Style and Success in Aging* (Presented at the 53rd Annual Meeting of the Am. Sociol. Soc., Seattle, Wash., August, 1958)
82. Demming, J. A., and Pressey, S. L. Tests "indigenous" to the adult and older years. *J. Counseling Psychol.*, 4, 144-48 (1957)
83. Dennis, W. Productivity among American psychologists. *Am. Psychologist*, 9, 191-94 (1954)
84. Dennis, W., and Girden, E. Current scientific activities of psychologists as a function of age. *J. Gerontol.*, 9, 175-78 (1954)
85. Dennis, W. Predicting scientific productivity in later maturity from records of earlier decades. *J. Gerontol.*, 9, 465-67 (1954)
86. Dennis, W. Age and achievement: a critique. *J. Gerontol.*, 11, 331-33 (1956)
87. Dennis, W. Age and productivity among scientists. *Science*, 123, 724-25 (1956)
88. Dent, R. W. Memory and the aging process. *Bull. Maritime Psychol. Assoc.*, 5, 12-15 (1956)
89. Donahue, W. (Ed.) *Education for Later Maturity* (Whiteside, Inc., New York, N. Y., 338 pp., 1955)
90. Donahue, W., Hunter, W. W., Coons, D. H., and Maurice, H. K. (Eds.) *Free Time: Challenge to Later Maturity* (University of Michigan Press, Ann Arbor, Mich., 172 pp., 1958)
91. Doppelt, J. E., and Wallace, W. L. Standardization of the Wechsler Adult Intelligence Scale for older persons. *J. Abnormal Social Psychol.*, 51, 312-30 (1955)
92. Doust, J. W. L. Studies on the physiology of awareness. Consciousness of the duration of time in psychiatric patients. *Diseases Nervous System*, 16, 2-4 (1955)
93. Dunham, H. Sociological aspects of mental disorders in later life. In *Mental Disorders of Later Life*, 2nd ed., Chap. 6, 157-77 (Kaplan, J., Ed., Stanford University Press, Stanford, Calif., 508 pp., 1956)
94. Engle, E. T., and Pincus, G. (Eds.) *Hormones and the Aging Process* (Academic Press, New York, N. Y., 323 pp., 1956)
95. Frankhauser, R. Veränderungen im der Wirbelsäule beim alternden Hund. *Schweiz. med. wochschr.*, 85, 65-70 (1955)
96. Federov, V. K. Physiological mechanism of the diminution conditioned reflexes with aging. *Zhurnal Vysshei Nervoi Deyatel'nosti*, 4, 568-73 (1954)
97. Feifel, H. Psychiatric patients look at old age: level of adjustment and attitudes toward aging. *Am. J. Psychiat.*, 111, 459-65 (1954)
98. Feifel, H. Older persons look at death. *Geriatrics*, 11, 127-30 (1956)
99. Feifel, H. Attitudes of mentally ill patients toward death. *J. Nervous Mental Disease*, 122, 375-80 (1955)
100. Feifel, H. *Attitudes Toward Death* (Presented at the 35th Annual Meeting of the American Orthopsychiatric Association, March, 1958)
101. Feifel, H. Judgment of time in younger and older persons. *J. Gerontol.*, 12, 71-74 (1957)
102. Fieandt, K., Huhtala, A., Kulberg, P., and Saari, K. Personal tempo and phenomenal time at different age-levels. *Report Psychological Institute, University of Helsinki, No. 2* (University of Helsinki, Helsinki, Finland, 25 pp., 1956)

103. Fink, H. F. The relationship of time perspective to age, institutionalization, and activity. *J. Gerontol.*, **12**, 414-17 (1957)
104. Fitzelle, G. T. Strength of opinion as an indication of philosophy of life: the relationship between strength of opinion and adjustment. *J. Am. Geriat. Soc.*, **3**, 306-10 (1955)
105. Fogel, E. J., Swepston, E. R., Zintek, S. S., Vernier, C. M., Fitzgerald, J. F., Marnocha, R. S., and Wechsler, C. H. Problems of the aging: conclusions derived from two years of interdisciplinary study of domiciliary members in a Veterans Administration center. *Am. J. Psychiat.*, **112**, 724-30 (1956)
106. Freeman, G. L. A high-level interest-values preference test for counselling pre-retirants. *J. Psychol.*, **46**, 121-39 (1958)
107. Freeman, G. L. Pre-retirant test scores in various hobby groups. *J. Psychol.*, **47**, 137-60 (1959)
108. Freeman, G. L., and Taylor, E. K. The construction of a test battery for counselling mature individuals with psychological retirement problems. *J. Psychol.*, **45**, 133-51 (1958)
109. Friedlander, W. J. Electroencephalographic alpha rate in adults as a function of age. *Geriatrics*, **13**, 29-31 (1958)
110. Friend, C. M., and Zubek, J. P. The effects of age on critical thinking ability. *J. Gerontol.*, **13**, 407-13 (1958)
111. Gerard, R. W. Aging and organization. In *Handbook of Aging and the Individual: Psychological and Biological Aspects*, Chap. 9 (Birren, J. E., Ed., University of Chicago Press, Chicago, Ill., 1959)
112. Gertz, B. The effect of handling at various age levels on emotional behavior of adult rats. *J. Comp. Physiol. Psychol.*, **50**, 613-16 (1957)
113. Ghiselli, E. E. The relationship between intelligence and age among superior adults. *J. Genet. Psychol.*, **90**, 131-42 (1957)
114. Gilbert, J. G. Age changes in color matching. *J. Gerontol.*, **12**, 210-15 (1957)
115. Gladis, M., and Braun, H. W. Age differences in transfer and retroaction as a function of intertask response similarity. *J. Exptl. Psychol.*, **55**, 25-30 (1958)
116. Glanzer, M., Glaser, R., and Richlin, M. Development of a test battery for study of age-related changes in intellectual and perceptual abilities. *School of Aviation Medicine, Rept. No. 56-138* (Randolph Air Force Base, Texas, March, 1958)
117. Golde, P., and Kogan, N. *A Test of the Generality of Beliefs and Attitudes Regarding Old People* (Presented at 11th Meeting, Gerontol. Soc., Philadelphia, Pa., 1958)
118. Goldfarb, A. I. Psychotherapy of the aged: the use and value of an adaptational frame of reference. *Psychoanal. Rev.*, **43**, 68-81 (1956)
119. Granick, S. Personality adjustment of the aged in retirement communities. *Geriatrics*, **12**, 381-85 (1957)
120. Gregory, I. An analysis of familial data on psychiatric patients: parental age, family size, birth order, and ordinal position. *Brit. J. Preventive & Social Med.*, **12**, 42-59 (1958)
121. Griew, S. Uncertainty as a determinant of performance in relation to age. *Gerontologia*, **2**, 284-89 (1958)
122. Griew, S. Information gain in tasks involving different stimulus-response relationships. *Nature*, **182**, 1819 (1958)
123. Griew, S. Age changes and information loss in performance of a pursuit tracking task involving interrupted preview. *J. Exptl. Psychol.*, **55**, 486-89 (1958)

124. Griew, S. A study of accidents in relation to occupation and age. *Ergonomics*, **2**, 17-23 (1958)
125. Griew, S., and Tucker, W. A. The identification of job activities associated with age differences in the engineering industry. *J. Appl. Psychol.*, **42**, 278-82 (1958)
126. Griew, S. A note on the effect of interrupting auditory signals on the performance of younger and older subjects. *Gerontologia*, **2**, 136-39 (1958)
127. Grotjahn, M. Analytic psychotherapy with the elderly. *Psychoanal. Rev.*, **42**, 419-27 (1955)
128. Guth, S. K., Eastman, A. A., and McNelis, J. F. Lighting requirements for older workers. *Illum. Eng.*, **51**, 656-60 (1956)
129. Guth, S. K. Effects of age on visibility. *Am. J. Optometry*, **34**, 463-77 (1957)
130. Hallervorden, J. Das normale und pathologische Altern des Gehirns. *Nervenarzt*, **28**, 433-45 (1957)
131. Hamasaki, D., Ong, J., and Marg, E. The amplitude of accommodation in presbyopia. *Am. J. Optometry*, **33**, 3-14 (1956)
132. Havighurst, R. J. Life styles of middle-aged people. *Vita Humana*, **2**, 25-34 (1959)
133. Havighurst, R. J. The social competence of middle-aged people. *Genet. Psychol. Monographs*, **56**, 297-375 (1957)
134. Havighurst, R. J. The leisure activities of the middle-aged. *Am. J. Sociol.*, **63**, 152-62 (1957)
135. Heron, A. Psychological changes with age: the present status of research. In *The Biology of Ageing*, 91-100 (Yapp, W. B., and Bourne, G. H., Eds., Hafner Publishing Co., Inc., New York, N. Y., 1957)
136. Himel, H. A., and MacDonald, R. I. A fallacy in clinical medicine; vibration sense in the aging and the aged. *Can. Med. Assoc. J.*, **77**, 459-62 (1957)
137. Himler, L. E., and Morisey, V. Factors influencing prognosis in psychiatric illness of the aged. *J. Am. Geriatr. Soc.*, **3**, 811-16 (1955)
138. Himwich, W. A., and Himwich, H. E. Neurochemistry of aging. In *Handbook of Aging and the Individual: Psychological and Biological Aspects*, Chap. 7 (Birren, J. E., Ed., University of Chicago Press, Chicago, Ill., 1959)
139. Holmberg, G. Influence of sex and age on convulsions induced by electric shock treatment. *A.M.A. Arch. Neurol. & Psychiat.*, **71**, 473-76 (1954)
140. Hopkins, B., and Post, F. The significance of abstract and concrete behaviour in elderly psychiatric patients and control subjects. *J. Ment. Sci.*, **101**, 841-50 (1955)
141. Howell, R. F. Changes in Wechsler subtest scores with age. *J. Consulting Psychol.*, **19**, 47-50 (1955)
142. Howell, R. J. Sex differences and educational influences on a mental deterioration scale. *J. Gerontol.*, **10**, 190-93 (1955)
143. Hurllock, E. B. *Developmental Psychology*, 2nd ed. (McGraw-Hill Book Co., New York, N. Y., 1959)
144. Inglis, J., Shapiro, M. B., and Post, F. "Memory function" in psychiatric patients over sixty. The role of memory in tests discriminating between "Functional" and "Organic" Groups. *J. Mental Sci.*, **102**, 589-98 (1956)
145. Inglis, J. An experimental study of learning and "memory function" in elderly psychiatric patients. *J. Mental Sci.*, **103**, 796-803 (1957)
146. Inglis, J. Psychological investigations of cognitive deficit in elderly psychiatric patients. *Psychol. Bull.*, **54**, 197-214 (1958)

147. Jarvik, L. F., Kallmann, F. J., Falek, A., and Klaber, M. M. Changing intellectual functions in senescent twins. *Acta Genet. et Statist. Med.*, **7**, 421-30 (1957)
148. Jerome, E. A. Age and learning-experimental studies. In *Handbook of Aging and the Individual: Psychological and Biological Aspects*, Chap. 19 (Birren, J. E., Ed., University of Chicago Press, Chicago, Ill., 1959)
149. Jones, A. W., and Rich, T. A. The Goodenough Draw-a-man Test as a measure of intelligence in aged adults. *J. Consulting Psychol.*, **21**, 235-38 (1957)
150. Jones, H. E. Problems of method in longitudinal research. *Vita Humana*, **1**, 93-99 (1958)
151. Jones, H. E., and Kaplan, O. J. Psychological aspects of mental disorders in later life. In *Mental Disorders in Later Life*, 2nd ed., Chap. 5, 98-156 (Kaplan, O. J., Ed., Stanford University Press, Stanford, Calif., 508 pp., 1956)
152. Jones, H. E. Intelligence and problem solving. In *Handbook of Aging and the Individual: Psychological and Biological Aspects*, Chap. 20 (Birren, J. E., Ed., University of Chicago Press, Chicago, Ill., 1959)
153. Jones, H. B. Human health relative to age, place, and time. In *Handbook of Aging and the Individual: Psychological and Biological Aspects*, Chap. 11 (Birren, J. E., Ed., University of Chicago Press, Chicago, Ill., 1959)
154. Kahn, R. L., Seaman, F. D., and Goldfarb, A. J. Attitudes toward illness in the aged. *Geriatrics*, **13**, 246-50 (1958)
155. Kahne, H. R., Ryder, C. M., Snegiriff, L. S., and Wyshak, G. Age and absenteeism. *A.M.A. Arch. Ind. Health*, **15**, 134-47 (1957)
156. Kallmann, F. J., Aschner, B., and Falek, A. Comparative data on longevity, adjustment to aging, and cause of death in a senescent twin population. In *Novant'anni delle Leggi Mendeliane*, 330-39 (Gedda, L., Ed., Institute Gregorio Mendel, Rome, Italy, 1955)
157. Kallmann, F. J. The genetics of aging. *J. Chronic Disease*, **4**, 140-52 (1956)
158. Kallmann, F. J. Twin data on the genetics of aging. *CIBA Foundation Colloq. on Aging*, **3**, 131-43 (1957)
159. Kallmann, F. J., and Jarvik, L. F. Individual differences in constitution and genetic background. In *Handbook of Aging and the Individual: Psychological and Biological Aspects*, Chap. 8 (Birren, J. E., Ed., University of Chicago Press, Chicago, Ill., 1959)
160. Kamin, L. J. Differential changes in mental abilities in old age. *J. Gerontol.*, **12**, 66-70 (1957)
161. Kaplan, O. J. (Ed.) *Mental Disorders in Later Life*, 2nd ed. (Stanford University Press, Stanford, Calif., 508 pp., 1956)
162. Kaplan, O. J. The aged subnormal. In *Mental Disorders in Later Life*, 2nd ed., Chap. 14, 383-97 (Kaplan, O. J., Ed., Stanford University Press, Stanford, Calif., 508 pp. 1956)
163. Kay, D. W., Roth, M., and Hopkins, B. Affective disorders arising in the senium. I. Their association with organic cerebral degeneration. *J. Ment. Sci.*, **101**, 302-16 (1955)
164. Kay, H. Some experiments on adult learning. In *Old Age in the Modern World, Proc. Intern. Assoc. Gerontol., 3rd Congr.*, 259-67 (London, England, 1954), (E. & S. Livingstone, London, England, 656 pp., 1955)
165. Kay, H. Theories of learning and aging. In *Handbook of Aging and the Individual: Psychological and Biological Aspects*, Chap. 18 (Birren, J. E., Ed., University of Chicago Press, Chicago, Ill., 1959)

166. Kelly, E. L. Consistency of the adult personality. *Am. Psychologist*, **10**, 659-81 (1955)
167. King, H. F. An age-analysis of some agricultural accidents. *Occupational Psychol.*, **29**, 245-253 (1955)
168. King, H. F. The response of older rural craftsman to individual training. *J. Gerontol.*, **10**, 207-11 (1955)
169. King, H. F. An attempt to use production data in the study of age and performance. *J. Gerontol.*, **11**, 410-16 (1956)
170. Kirchner, W. K. Age differences in short-term retention of rapidly changing information. *J. Exptl. Psychol.*, **55**, 352-58 (1958)
171. Kirchner, W. K. The attitudes of special groups toward the employment of older persons. *J. Gerontol.*, **12**, 216-20 (1957)
172. Kleemeier, R. W., and Justiss, W. A. Adjustment to hearing loss and to hearing aids in old age. In *Aging and Retirement*, 34-48 (Webber, I. L., Ed., University of Florida Press, Gainesville, Fla., 1955)
173. Kleemeier, R. W. Environmental settings and the aging process. In *Psychological Aspects of Aging*, 105-16 (Anderson, J. E., Ed., American Psychological Association, Washington, D. C., 323 pp., 1956)
174. Kleemeier, R. W., Rich, T. A., and Justiss, W. A. The effects of alpha-(2-piperidyl) benzhydrol hydrochloride (Merafran) on psychomotor performance in a group of aged males. *J. Gerontol.*, **11**, 165-70 (1956)
175. Kleemeier, R. W. Behavior and the organization of the bodily and the external environment. In *Handbook of Aging and the Individual: Psychological and Biological Aspects*, Chap. 13 (Birren, J. E., Ed., University of Chicago Press, Chicago, Ill., 1959)
176. Kogan, N. *Attitudes toward Old People: the Development of a Scale and an Examination of Correlates* (Presented at 30th Eastern Psychol. Assoc. Meeting, Atlantic City, N. J., April, 1959)
177. Kolb, L. The mental hospitalization of the aged: is it being overdone? *Am. J. Psychiat.*, **112**, 627-35 (1956)
178. König, E. Pitch discrimination and age. *Acta Otol-Laryngol.*, **48**, 475-89 (1957)
179. Korchin, S. J., and Basowitz, H. Age differences in verbal learning. *J. Abnormal Soc. Psychol.*, **54**, 64-69 (1957)
180. Korchin, S. J., and Basowitz, H. The judgment of ambiguous stimuli as an index of cognitive functioning in aging. *J. Personality*, **25**, 81-95 (1956)
181. Kornzweig, A. L., Feldstein, M., and Schneider, J. The eye in old age. IV. Ocular survey of over one thousand persons with special reference to normal and disturbed visual function. *Am. J. Ophthalmol.*, **44**, 29-37 (1957)
182. Koskenoja, M., and Orma, E. J. Positional nystagmus in elderly patients with postural dizziness. *Ann. Otol., Rhinol. & Laryngol.*, **65**, 707 (1956)
183. Kral, V. A. Neuropsychiatric observations in an old people's home. *J. Gerontol.*, **13**, 169-76 (1958)
184. Kuhlen, R. G. Aging and life adjustment. In *Handbook of Aging and the Individual: Psychological and Biological Aspects*, Chap. 24 (Birren, J. E., Ed., University of Chicago Press, Chicago, Ill., 1959)
185. Kumnick, L. S. Aging and pupillary response to light and sound stimuli. *J. Gerontol.*, **11**, 38-45 (1956)
186. Kumnick, L. S. Aging and decay of pupillary psychosensory restitution. *J. Gerontol.*, **11**, 46-52 (1956)

187. Kumnick, L. S. Aging and the efficiency of the pupillary mechanism. *J. Gerontol.*, **11**, 160-64 (1956)
188. Kumnick, L. S. Aging and the latency and duration of pupil constriction in response to light and sound stimuli. *J. Gerontol.*, **11**, 391-96 (1956)
189. Kumnick, L. S. Pupillary psychosensory restitution and aging. *J. Optical Soc. Am.*, **44**, 735-41 (1954)
190. Kutner, B., Fanshel, D., Togo, A. M., and Langner, T. *Five Hundred Over Sixty* (Russell Sage Foundation, New York, N. Y., 345 pp., 1956)
191. Lakin, M. Clinical use of the Bender Visual Motor Test in psychologic assessment of the aged. *J. Am. Geriat. Soc.*, **4**, 909-19 (1956)
192. Lakin, M. Affective tone in human figure drawings by institutionalized aged and by normal children. *J. Am. Geriat. Soc.*, **6**, 495-500 (1958)
193. Lakin, M. Certain formal characteristics of human figure drawing by institutionalized aged and by normal children. *J. Consulting Psychol.*, **20**, 471-74 (1956)
194. Landahl, H. D. Biological periodicities, mathematical biology and aging. In *Handbook of Aging and the Individual: Psychological and Biological Aspects*, Chap. 3 (Birren, J. E., Ed., University of Chicago Press, Chicago, Ill., 1959)
195. Landahl, H. D., and Birren, J. E. Effects of age on the discrimination of lifted weights. *J. Gerontol.*, **14**, 48-55 (1959)
196. Landahl, H. D., and Hasegawa, A. T. The Influence of exposure to low levels of gamma and fast neutron irradiation on the life span of mice. II. Effect of irradiation by gamma rays and neutrons on the reaction time of mice. *U.S.A.F. Radiation Lab. Rept.*, No. 30 (Chicago, Ill., January, 1959)
197. Landis, C., and Hamwi, V. Critical flicker frequency, age, and intelligence. *Am. J. Psychol.*, **69**, 459-61 (1956)
198. Lansing, A. I. General biology of senescence. In *Handbook of Aging and the Individual: Psychological and Biological Aspects*, Chap. 4 (Birren, J. E., Ed., University of Chicago Press, Chicago, Ill., 1959)
199. Larsson, K. Sexual activity in senile male rats. *J. Gerontol.*, **13**, 136-39 (1958)
200. Larsson, K. Age differences in the diurnal periodicity of male sexual behavior. *Gerontologia*, **2**, 64-72 (1958)
201. Larssen, N. A. Cerebral blood flow and oxygen consumption in man. *Physiol. Rev.*, **39**, 183-238 (1959)
202. Lehman, H. C. Reply to Dennis' critique of age and achievement. *J. Gerontol.*, **11**, 333-37 (1956)
203. Lehman, H. C. Jobs for those over sixty-five. *J. Gerontol.*, **10**, 345-57 (1955)
204. Lepkowski, J. R. The attitudes and adjustments of institutionalized and non-institutionalized Catholic aged. *J. Gerontol.*, **11**, 185-91 (1956)
205. Levi, M. Development of a test battery for the selection of a/c material dispatchers, *Project No. EM-56-4* (Personnel Research and Measurement Section, McClellan Air Force Base, Calif., February, 1958)
206. Levi, M., and LaRue, E. Age, speed and accuracy, intelligence level, and several other aptitudes as related to job success of materials dispatcher employees. *Perceptual & Motor Skills*, **7**, 213 (1957)
207. Light, B. H., and Amick, J. H. Rorschach responses of normal aged. *J. Projective Techniques*, **20**, 185-95 (1956)
208. Liss, L., and Gomez, F. The nature of senile changes of the human olfactory bulb and tract. *A.M.A. Arch. Otolaryngol.*, **67**, 167-71 (1958)

209. Lloyd, R. G. Social and personal adjustment of retired persons. *Sociol. & Social Research*, **39**, 312-16 (1955)
210. Logan, W. P. D. Work and age: statistical considerations. *Brit. Med. J.*, **II**, 1190-93 (1953)
211. Lorge, I. Aging and intelligence. The neurological and psychiatric aspects of the disorders of aging. *Proc. Assoc. Research Nervous Mental Disease*, **35**, 46-60 (The Williams & Wilkins Co., Baltimore, Md., 1956)
212. Lorge, I., Tuckman, J., and Dunn, M. B. Human figure drawings by younger and older adults. *J. Clin. Psychol.*, **14**, 54-56 (1958)
213. Lorge, I., and Tuckman, J. Attitude toward aging of individuals with experiences with the aged. *J. Genet. Psychol.*, **92**, 199-204 (1958)
214. Mack, M. J. Personal adjustment of chronically ill old people under home care. *Geriatrics*, **8**, 407-16 (1953)
215. Mack, M. J. An evaluation of a retirement-planning program. *J. Gerontol.*, **13**, 198-202 (1958)
216. Madonick, M. J. Statistical control studies in neurology. 8. The cutaneous abdominal reflex. *Neurology*, **7**, 459-65 (1957)
217. Maggs, R., and Turton, E. C. Some EEG findings in old age and their relationship to affective disorder. *J. Mental Sci.*, **102**, 812-18 (1956)
218. Magladery, J. W. Neurophysiology of aging. In *Handbook of Aging and the Individual: Psychological and Biological Aspects*, Chap. 6 (Birren, J. E., Ed., University of Chicago Press, Chicago, Ill., 1959)
219. Magladery, J. W., Teasdall, R. D., and Norris, A. H. Effects of aging on plantar flexor and superficial abdominal reflexes in man: a clinical and electromyographic study. *J. Gerontol.*, **13**, 282-88 (1958)
220. Maher, H. Age and performance of two work groups. *J. Gerontol.*, **10**, 448-51 (1955)
221. Mangan, G. L., and Clark, J. W. Rigidity factors in the testing of middle-aged subjects. *J. Gerontol.*, **13**, 422-25 (1958)
222. Mangan, G. L. Method-of-approach factors in the testing of middle-aged subjects. *J. Gerontol.*, **13**, 55-59 (1958)
223. Manniche, E., and Falk, G. Age and the Nobel prize. *Behavioral Sci.*, **2**, 301-7 (1957)
224. Marg, E., and Reeves, J. L. Accomodative response of the eye of an aged cat to electrical stimulation of the ciliary ganglion. *J. Opt. Soc. Am.*, **45**, 926-28 (1955)
225. McAdam, W., and Robinson, R. A. Prognosis in senile deterioration. *J. Ment. Sci.*, **103**, 821-23 (1957)
226. McAdam, W., and Robinson, R. A. Senile intellectual deterioration and the electroencephalogram: a quantitative correlation. *J. Mental Sci.*, **102**, 819-825 (1956)
227. McCulloch, T. L. The retarded child grows up; psychological aspects of aging. *Am. J. Mental Deficiency*, **62**, 201-8 (1957)
228. McFarland, R., and O'Doherty, B. Work and occupational skills. In *Handbook of Aging and the Individual: Psychological and Biological Aspects*, Chap. 14 (Birren, J. E., Ed., University of Chicago Press, Chicago, Ill., 1959)
229. McFarland, R. A. *Human Factors in Air Transportation* (McGraw-Hill Book Co., New York, N. Y., 830 pp., 1953)

230. McFarland, R. A., and Fisher, M. B. Alterations in dark adaptation as a function of age. *J. Gerontol.*, **10**, 424-28 (1955)
231. McFarland, R. A. Psycho-physiological problems of aging in air transport pilots. *J. Aviation Med.*, **25**, 210-20 (1954)
232. McFarland, R. A., Moseley, A. L., and Fisher, M. B. Age and the problems of professional truck drivers in highway transportation. *J. Gerontol.*, **9**, 338-48 (1954)
233. McMahan, C. A., and Ford, T. R. Surviving the first five years of retirement. *J. Gerontol.*, **10**, 212-15 (1955)
234. McMahan, C. A., and Ford, T. R. Rejoinder. *J. Gerontol.*, **11**, 205 (1956)
235. Meltzer, H. Age differences in work attitudes. *J. Gerontol.*, **13**, 74-81 (1958)
236. Miner, R. W. (Ed.) Parental age and characteristics of the offspring. *Ann. N. Y. Acad. Sci.*, **57**, 451-614 (1954)
237. Mitchell, J. M., Jr. An hypothesis of psychological aging. *Am. J. Psychol.*, **70**, 459-62 (1957)
238. Morgan, A. B. Differences in logical reasoning associated with age and higher education. *Psychol. Repts.*, **2**, 235-40 (1956)
239. Morrison, L. R. *The Effects of Advancing Age upon the Spinal Cord* (Harvard University Press, Cambridge, Mass., 127 pp., 1959)
240. Murrell, K. F. H., and Griew, S. Age structure in the engineering industry: a study of regional effects. *Occupational Psychol.*, **32**, 86-88 (1958)
241. Murrell, K. F. H., Griew, S., and Tucker, W. A. Age structure in the engineering industry: a preliminary study. *Occupational Psychol.*, **31**, 150-168 (1957)
242. Mysak, E. D., and Hanley, T. D. Aging processes in speech: pitch and duration characteristics. *J. Gerontol.*, **13**, 309-13 (1958)
243. Nash, F. A. Observations of real age and apparent age. *J. Am. Geriat. Soc.*, **6**, 515-21 (1958)
244. Neugarten, B. L., and Gutman, D. L. Age-sex roles and personality in middle age: a thematic apperception study. *Psychol. Monographs*, **72**(17), 33 pp. (1958)
245. Nisbet, J. D. Intelligence and age: retesting with twenty-four years' interval. *Brit. J. Educ. Psychol.*, **27**, 190-98 (1957)
246. Nyssen, R. El problema de la involucion de las capacidades intelectuales. *Rev. psicol. gen. appl.*, **8**, 259-63 (1953)
247. Obrist, W. D. The electroencephalogram of normal aged adults. *EEG Clin. Neurophysiol.*, **6**, 235-44 (1954)
248. Obrist, W. D., and Henry, C. E. Electroencephalographic findings in aged psychiatric patients. *J. Nervous Mental Disease*, **126**, 254-67 (1958)
249. Obrist, W. D., and Henry, C. E. Electroencephalographic frequency analysis of aged psychiatric patients. *EEG Clin. Neurophysiol.*, **10**, 621-32 (1958)
250. Obrist, W. D., and Bissell, L. F. The electroencephalogram of aged patients with cardiac and cerebral vascular disease. *J. Gerontol.*, **10**, 315-30 (1955)
252. Ohrbach, H. L. *Age and Religious Participation in a Large Metropolitan Area* (Presented at 11th Meeting, Gerontol. Soc., Philadelphia, Pa., 1958)
253. Olsen, I. A., and Elder, J. H. A word association test of emotional disturbance in older women. *J. Gerontol.*, **13**, 305-8 (1958)
254. O'Neill, J. J. Ohio county fair hearing survey. *J. Speech & Hearing Disorders*, **21**, 188-97 (1956)
255. O'Neal, P., Robins, E., and Schmidt, E. H. A psychiatric study of attempted

- suicide in persons over sixty years of age. *A.M.A. Arch. Neurol. Psychiat.*, **75**, 275-4 (1956)
256. Orma, E. J., and Voutilainen, A. Roentgenological changes of the cervical spine in elderly patients with postural dizziness. *Ann. Med. Internal Fenniae.*, **46**, 61-67, (1957)
257. Orma, E. J., and Koskenoja, M. Postural dizziness in the aged. *Geriatrics*, **12**, 49-59 (1957)
258. Orma, E. J., and Koskenoja, M. Dizziness attacks and continuous dizziness in the aged. *Geriatrics*, **12**, 92-100 (1957)
259. Orme, J. E. Intellectual and Rorschach test performances of a group of senile dementia patients and of a group of elderly depressives. *J. Ment. Sci.*, **101**, 863-70 (1955)
260. Orme, J. E. Non-verbal and verbal performance in normal old age, senile dementia, and elderly depression. *J. Gerontol.*, **12**, 408-13 (1957)
261. Orme, J. E. Rorschach performances in normal old age, elderly depression and senile dementia. *Rev. Diagnostic Psychol. & Personality Exploration*, **6**, 132-41 (1958)
262. Osaka University, *Memoirs of the Faculty of Letters*, **6** (Osaka University, Osaka, Japan, 357 pp., March, 1958)
263. Osborne, R. T., and Sanders, W. B. Differential decline in Graduate Record Examination scores with age. *J. Genet. Psychol.*, **87**, 309-16 (1955)
264. Pacaund, S. Experimental research on the aging of psychological functions. In *Old Age in the Modern World, Proc. Intern. Assoc. Gerontol.*, 3rd Congr. 279-89 (London, England, 1954) (E. & S. Livingstone, London, England, 656 pp., 1955)
265. Pacaud, S. Le vieillissement des aptitudes; déclin des aptitudes en fonction de l'âge et du niveau d'instruction. *Biotypologie*, **14**, 65-94 (1953)
266. Pacaud, S. Le vieillissement des aptitudes. In *Précis de gerontologie*, Chap. 2, 40-67 (Binet, L., and Bourliere, F., Eds., Masson & Cie, Paris, France, 1955)
267. Pampiglione, G., and Post, F. The value of electroencephalographic examinations in psychiatric disorders of old age. *Geriatrics*, **13**, 725-32 (1958)
268. Pappas, W., and Silver, R. J. Developmental differences between the successful and unsuccessful aged. *J. Am. Geriat. Soc.*, **6**, 360-67 (1958)
269. Pestalozza, G., Davis, H., Eldredge, D. H., Covell, W. P., and Rogers, J. G. Decreased bio-electric potentials in the ears of senile guinea pigs. *Laryngoscope*, **67**, 1113-22 (1957)
270. Phillips, B. S. A role theory approach to adjustment to old age. *Am. Sociol. Rev.*, **22**, 212-17 (1957)
271. Pierson, W. R., and Montoye, H. J. Movement time, reaction time, and age. *J. Gerontol.*, **13**, 418-21 (1958)
272. Pineau, H. Étude statistique des variations en fonction de l'âge de quelques caractères physiques et psychologiques chez un groupe d'ouvrières. *Biotypologie*, **16**, 10-26 (1955)
273. Pineau, S. R., and Jones, H. E. Mental development in infancy and childhood and mental abilities in adult life. *Rev. of Educ. Research*, **25**, 415-37 (1955)
274. Pliskin, B., Baumatz, S., Radt, P., and Riechenbach, B. Psychiatric problems of aged immigrants in Israel. *Geriatrics*, **13**, 783-89 (1958)
275. Pollack, M., Kahn, R. L., and Goldfarb, A. I. Factors related to individual

- differences in perception in institutionalized age subjects. *J. Gerontol.*, **13**, 192-97 (1958)
276. Pressey, S. L. Potentials of age: an exploratory field study. *Genet. Psychol. Monographs.*, **56**, 159-205 (1957)
277. Pressey, S. L., and Jones, A. W. 1923-1953 and 20-60 age changes in moral codes, anxieties, and interests as shown by the "X-O Tests." *J. Psychol.*, **39**, 485-502 (1955)
278. Pressey, S. L., and Kuhlen, R. G. *Psychological Development Through the Life Span* (Harper & Brothers, New York, N. Y., 654 pp. 1957)
279. Rechtschaffen, A. Psychotherapy with geriatric patients: a review of the literature. *J. Gerontol.*, **14**, 73-84 (1959)
280. Reichenbach, M., and Mathers, R. A. The place of time and aging in the natural sciences and scientific philosophy. In *Handbook of Aging and the Individual: Psychological and Biological Aspects*, Chap. 2 (Birren, J. E., Ed., University of Chicago Press, Chicago, Ill., 1959)
281. Reitan, R. M. Investigation of relationships between "psychometric" and "biological" intelligence. *J. Nervous Mental Disease*, **123**, 536-41 (1956)
282. Reitan, R. M. The distribution according to age of a psychologic measure dependent upon organic brain function. *J. Gerontol.*, **10**, 338-40 (1955)
283. Riegel, K. F. Ergebnisse und Probleme der psychologischen Altersforschung. *Vita Humana*, **1**, No. 1, 52-64 (1958); No. 2, 111-28 (1958)
284. Riegel, K. F. Ergebnisse und probleme der psychologischen Altersforschung. *Vita Humana*, **1**, 204-43 (1958)
285. Riegel, K. F. Personality theory and aging. In *Handbook of Aging and the Individual: Psychological and Biological Aspects*, Chap. 23 (Birren, J. E., Ed., University of Chicago Press, Chicago, Ill., 1959)
286. Robertson, J. P. S. Age, vocabulary, anxiety, and brain damage as factors in verbal learning. *J. Consulting Psychol.*, **21**, 179-82 (1957)
287. Rocklyn, E. H., Hessert, R. B., and Braun, H. W. Calibrated materials for verbal learning with middle and old-age subjects. *Am. J. Psychol.*, **70**, 628-30 (1957)
288. Rockstein, M. Longevity of male and female house flies. *J. Gerontol.*, **12**, 253-56 (1957)
289. Rose, A. M. Factors associated with the life satisfaction of middle-class, middle-aged persons. *Marriage & Family Living*, **17**, 15-19 (1955)
290. Sataloff, J. Presbycusis. *A.M.A. Arch. Otolaryngol.*, **66**, 271-74 (1957)
291. Schaie, K. W. Rigidity-flexibility and intelligence: a cross-sectional study of the adult life span from 20 to 70 years. *Psychol. Monographs*, **72**(9), 26 pp. (1958)
292. Schenk, H., and Pfeifer, H. Untersuchungen des Gesichtsfeldes und der Dunkeladaptation bei seniler Pigmententartung der Netzhaut. *Arch. Ophthalmol., Graefe's (Munich)*, **158**, 326-33 (1957)
293. Schuknecht, H. F. Presbycusis. *Laryngoscope*, **65**, 402-19 (1955)
294. Scott, F. G. Factors in the personal adjustment of institutionalized and non-institutionalized aged. *Am. Sociol. Rev.*, **20**, 538-46 (1955)
295. Shames, G. H., and Beams, H. L. Incidence of stuttering in older age groups. *J. Speech & Hearing Disorders*, **21**, 313-16 (1956)
296. Shanas, E. Facts versus stereotypes: the Cornell study of occupational retirement. *J. Social Issues*, **14**, 61-63 (1958)
297. Shapior, M. B., Field, J., and Post, F. An enquiry into the determinants of a

- differentiation between elderly "organic" and "non-organic" psychiatric patients on the Bender Gestalt Test. *J. Mental Sci.*, **103**, 364-74 (1957)
298. Sheldon, H. D. *The Older Population of the United States* (John Wiley & Sons, Inc., New York, N. Y., 223 pp., 1958)
299. Shepard, W. P. Does the modern pace really kill? *J. Am. Geriat. Soc.*, **3**, 139-45 (1955)
300. Sherman, E. D. Sensitivity to pain. *Can. Med. Assoc. J.*, **48**, 437-41, (1943)
301. Shock, N. W. *Trends in Gerontology*, 2nd ed. (Stanford University Press, Stanford, Calif., 214 pp., 1957)
302. Shooter, A. M. N., Schoenfeld, A. E. D., King, H. F., and Welford, A. T. Some field data on the training of older people. *Occupational Psychol.* **30**, 204-215 (1956)
303. Shrut, S. D. Evaluation of two aged populations living under two modes of institutional residence within the same institution: implications and recommendation. *J. Am. Geriat. Soc.*, **6**, 44-59 (1958)
304. Shrut, S. D. Attitudes toward old age and death. *Mental Hygiene*, **42**, 259-66 (1958)
305. Silverman, A. J., Busse, E. W., and Barnes, R. H. Studies in the processes of aging: electroencephalographic findings in 400 elderly subjects. *EEG Clin. Neurophysiol.*, **7**, 67-74, (1955)
306. Silverman, A. J., Busse, E. W., Barnes, R. H., Frost, L. L., and Thaler, M. B. Studies on the processes of aging: physiologic influences on psychic functioning in elderly people. *Geriatrics*, **8**, 370-76 (1953)
307. Simonson, E. Clinical medicine symposium: functional capacities of older individuals. *J. Gerontol.*, **13**, Suppl. 2, 18-26 (1958)
308. Singleton, W. T. The change of movement timing with age. *Brit. J. Psychol.*, **45**, 166-72 (1954)
309. Singleton, W. T. Age and performance timing on simple skills. In *Old Age in the Modern World, Proc. Intern. Assoc. Gerontol. 3rd Congr.*, 221-31 (London, England, 1954) (E. & S. Livingstone, London, England, 656 pp., 1955)
310. Smith, B. J. *Age and Pilot Performance: Study of Difference in Performance Among Various Age Groups as Indicated by Reports of Near-accidents Controlled for Exposure* (Headquarters 8th Air Force, Office of the Surgeon, Research Branch, Fort Worth, Texas, 311 pp., 1955)
311. Smith, J. M. The effects of temperature and egg-laying on the longevity of *Drosophila subobscura*. *J. Exptl. Biol.*, **35**, 832-42 (1958)
312. Smith, J. M. Genetic variations in ageing. In *The Biology of Ageing*, 115-22 (Yapp, W. B., and Bourne, G. H., Eds., Hafner Publishing Co., Inc., New York, N. Y., 1957)
313. Smith, M. E. Relation between word variety and mean letter length of words with chronological and mental ages. *J. Gen. Psychol.*, **56**, 27-43 (1957)
314. Smith, M. E. The application of some measures of language behavior and tension to the letters written by a woman at each decade of her life from 49 to 89 years of age. *J. Gen. Psychol.*, **57**, 289-95 (1957)
315. Smith, W. M., Jr., Britton, J. H., and Britton, J. O. *Relationships within Three-Generation Families* (College of Home Economics Research Publication, Pennsylvania State University, University Park, Pa., 155 pp., 1958)
316. Stanton, J. E. Some factors affecting employment in relation to age. *Abstracts of Doctoral Dissertations*, No. 66 (The Ohio State University Press, Columbus, Ohio, 1955)

317. Stennett, R. G., and Thurlow, M. Cultural symbolism: the age variable. *J. Consulting Psychol.*, **22**, 496 (1958)
318. Stephens, J. W., Cawthorne, F. M., and Kogan, N. *Young Children's Perception of Age Differences* (Presented at 30th Eastern Psychol. Assoc. Meeting, Atlantic City, N. J., April, 1959)
319. Streib, G. F. Family patterns in retirement. *J. Social Issues*, **14**, 46-60 (1958)
320. Streib, G. F., Thompson, W. E., and Suchman, E. A. The Cornell study of occupational retirement. *J. Social Issues*, **14**, 3-17 (1958)
321. Streib, G. F., and Thompson, W. *Value Orientations and Interpersonal Relations* (Presented at 52nd Annual Meeting, Am. Sociol. Soc., Washington, D. C., 1957)
322. Streib, G. F. Morale of the retired. *Social Problems*, **3**, 270-76 (1956)
323. Strom, A. An investigation of the living conditions and health of 1389 persons aged 70 years of more in Norway. *J. Gerontol.*, **11**, 178-84 (1956)
324. Strother, C. R., Schaie, K. W., and Horst, P. The relationship between advanced age and mental abilities. *J. Abnormal Social Psychol.*, **55**, 166-70 (1957)
325. Szafran, J. Changes with age and with exclusion of vision in performance at an aiming task. *Quart. J. Exptl. Psychol.*, **3**, 111-18 (1951)
326. Szafran, J. Experiments on the greater use of vision by older adults. In *Old Age in the Modern World, Proc. Intern. Assoc. Gerontol.*, 3rd, 231-35 (London, England, 1954) (E. & S. Livingstone, London, England, 656 pp., 1955)
327. Szilard, L. On the nature of the aging process. *Proc. Nat. Acad. Sci.*, **45**, 30-45 (1959)
328. Tamplin, A. R. Quantitative aspects of the relationship of biological measurements to aging processes. *J. Gerontol.*, **14**, 134-55 (1959)
329. Taylor, C., and Thompson, G. G. Age trend in preferences for certain facial proportions. *Child Development*, **26**, 97-102 (1955)
330. Thaler, M. Relationships among Wechsler, Weigl, Rorschach, EEG findings, and abstract-concrete behavior in a group of normal aged subjects. *J. Gerontol.*, **11**, 404-09 (1956).
331. Thompson, W. E., and Streib, G. F. Situational determinants: health and economic deprivation in retirement. *J. Social Issues*, **14**, 18-34 (1958)
332. Thompson, W. E. Pre-retirement anticipation and adjustment in retirement. *J. Social Issues*, **14**, 35-45 (1958)
333. Thompson, W., and Streib, G. F. *Retirement and Health* (Presented at 10th Meeting, Gerontol. Soc., Inc., Cleveland, Ohio, 1957)
334. Tompkins, D. C. *The Senile Aged Problem in the United States* (Bureau of Public Administration, University of California, Berkeley, Calif., 82 pp., 1955)
335. Townsend, P. *The Family Life of Old People* (George Routledge & Kegan Paul, London, England, 284 pp., 1957)
336. Tuckman, J., and Lorge, I. Old people's appraisal of adjustment over the life span. *J. Personality*, **22**, 417-22 (1954)
337. Tuckman, J., and Lorge, I. Classification of the self as young, middle-aged, or old. *Geriatrics*, **9**, 534-36 (1954)
338. Tuckman, J., and Lorge, I. The influence of changed directions on stereotypes about aging: before and after instruction. *Educ. Psychol. Measurement*, **14**, 128-32 (1954)
339. Tuckman, J. Retirement attitudes of compulsory and non-compulsory retired workers. *Geriatrics*, **11**, 569-72 (1956)

340. Tuckman, J., and Lorge, I. Attitude toward aging of individuals with experiences with the aged. *J. Genet. Psychol.*, **92**, 199-204 (1958)
341. Tuckman, J., and Lorge, I. Perceptual stereotypes about life adjustments. *J. Social Psychol.*, **43**, 239-45 (1956)
342. Tuckman, J., and Lavell, M. Self-classification as old or not old. *Geriatrics*, **12**, 666-71 (1957)
343. Tuckman, J., Lorge, I., and Zeman, F. D. Retesting older people with the Cornell Medical Index and with the Supplementary Health Questionnaire. *J. Gerontol.*, **9**, 306-8 (1954)
344. Tuckman, J., and Lorge, I. The projection of personal symptom into stereotype about aging. *J. Gerontol.*, **13**, 70-73 (1958)
345. Tuckman, J., and Lavell, M. Study of suicide in Philadelphia. *Public Health. Repts. (U. S.)*, **73**, 547-53 (1958)
346. Tunbridge, R. E. A scientist looks at problems of aging. *UNESCO Courier*, **11**, 11-25 (1958)
347. U. S. Department of Commerce. *The Age Distribution of Captains in Air Carrier Accidents* (Civil Aeronautics Administration, Office of Aviation Safety, Washington, D. C., 8 pp., 1956)
348. U. S. Department of Health, Education and Welfare. Suicide. *Vital Statistics—Special Reports*, **43**, No. 30 (Public Health Service, National Office of Vital Statistics, Washington, D. C., 1956)
349. van Zonneveld, R. J. An orientation study of the memory of old people. *Geriatrics*, **13**, 532-34 (1958)
350. van Zonneveld, R. J. Public health and the aged in Europe. *J. Gerontol.*, **13**, Suppl. 1, 68-91 (1958)
351. Verzar-McDougall, E. J. Studies in learning and memory in aging rats. *Gerontology*, **1**, 65-85 (1957)
352. von Gerfeldt, E. Differenzierte krankheitsanfälligkeit. *Vita Humana*, **1**, 19-42 (1958)
353. von Lehr, U., and Thomae, H. Eine längsschnittuntersuchung bei 30-bis 50-jährigen angestellten. *Vita Humana*, **1**, 100-10 (1958)
354. von Mering, O., and Weniger, F. L. Social-cultural background of the aging individual. In *Handbook of Aging and the Individual: Psychological and Biological Aspects*, Chap. 10 (Birren, J. E., Ed., University of Chicago Press, Chicago, Illinois, 1959)
355. Wallace, J. G. Some studies of perception in relation to age. *Brit. J. Psychol.*, **47**, 283-97 (1956)
356. Wallach, M. A., and Kogan, N. *Sex Differences and Judgment Processes* (Mimeographed form) (Harvard University and the Age Center of New England, Inc., Cambridge, Mass., 1959)
357. Wallach, M. A., and Kogan, N. *Certainty of Judgment and the Evaluation of Risk* (Mimeographed form) (Harvard University and the Age Center of New England, Inc., Cambridge, Mass., 1959)
358. Walters, R. H., and Zaks, M. S. Changes in responses to a set of personality-inventory items as a function of age. *J. Consulting Psychol.*, **22**, 458 (1958)
359. Walton, D. The diagnostic and predictive accuracy of the Wechsler Memory Scale in psychiatric patients over 65. *J. Mental Sci.*, **104**, 1111-18 (1958)
360. Walton, D. The diagnostic and predictive accuracy of the modified word

- learning test in psychiatric patients over 65. *J. Mental Sci.*, **104**, 1119-22 (1958)
361. Wanklin, J. M., Egner, K. M., Buck, C., and Hobbs, G. E. A comparative study of elderly mental hospital patients and residents for homes for the aged. *J. Gerontol.*, **13**, 60-69 (1958)
362. Wayner, M. J., Jr., and Emmers, R. Spinal synaptic delay in young and aged rats. *Am. J. Physiol.*, **194**, 403-5 (1958)
363. Wechsler, D. *Manual for the Wechsler Adult Intelligence Scale* (Psychological Corporation, New York, N. Y., 110 pp., 1955)
364. Wechsler, D. The measurement and evaluation of intelligence of older persons. In *Old Age in the Modern World*, 275-79 (E. & S. Livingstone, Edinburgh, Scotland, 1955)
365. Weiss, A. D. Sensory functions. In *Handbook of Aging and the Individual: Psychological and Biological Aspects*, Chap. 15 (Birren, J. E., Ed., University of Chicago Press, Chicago, Ill., 1959)
366. Welford, A. T. Psychomotor performance. In *Handbook of Aging and the Individual: Psychological and Biological Aspects*, Chap. 17 (Birren, J. E., Ed., University of Chicago Press, Chicago, Ill., 1959)
367. Welford, A. T. Age and learning: theory and needed research. In *Experimental Research on Aging*, Chap. 18, 136-44 (Verzar, F., Ed., Birkhäuser Verlag, Basel, Switzerland, 1956)
368. Welford, A. T. *Ageing and Human Skill* (Oxford University Press, London, England, 300 pp., 1958)
369. Welford, A. T. Psychological aspects of ageing. In *Modern Trends in Geriatrics*, Chap. 4, 69-105 (Hobson, W., Ed., Butterworth & Co. Ltd., London, England, 1957)
370. Welford, A. T. Psychological and social gerontology in Europe. *J. Gerontol.*, **13**, Suppl. 1, 51-67 (1958)
371. Wesman, A. G. Standardizing an individual intelligence test on adults: some problems. *J. Gerontol.*, **10**, 216-19 (1955)
372. Williams, M. A test for residual mental ability in senile dementia. *J. Mental Sci.*, **104**, 783-91 (1958)
373. Williams, W. S., and Jaco, E. G. An evaluation of functional psychosis in old age. *Am. J. Psychiat.*, **114**, 910-16 (1958)
374. Williams, W. S., and Jaco, E. G. A re-examination of mental illness in old age. *Diseases Nervous System*, **18**, 1-4 (1957)
375. Wimer, R. E. *Learning and Retention in Old Age* (Doctoral thesis, McGill University, Montreal, Canada, 1958)
376. Wimer, R. E., Wigdor, B. T. Age differences in retention of learning. *J. Gerontol.*, **13**, 291-95 (1958)
377. Zangwill, O. L., and Cantab, M. A. Disorientation for age. *J. Mental Sci.*, **99**, 698-701 (1953)
378. Zubek, J. P., and Solberg, P. A. *Human Development* (McGraw-Hill Book Co., New York, N. Y., 476 pp. 1955)

STATISTICS¹

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INTRODUCTION

In searching for introductory remarks, it occurred to the reviewer that readers might be interested in seeing which journals have been cited most frequently in the chapters on statistics in the preceding 10 volumes of the *Annual Review of Psychology*. To the results in Table I is added the note that the total number of references (books, etc., as well as journals) in any one year varied from 33 to 143. The interpretation and implications of Table I are left to the reader. Its effect on the reviewer was a decision to attempt an excursive rather than a highly selective survey of the statistical and psychometric literature.

TABLE I

TEN JOURNALS CITED MOST FREQUENTLY IN THE CHAPTERS ON STATISTICAL METHODS IN THE PREVIOUS TEN-YEAR HISTORY (1950-59) OF THE *Annual Review of Psychology*

Rank	Journal	Mean Citations Per Year	No. Years Cited at Least Once	Range of Citations Per Year
1	<i>Psychometrika</i>	16.2	10	4 to 28
2	<i>J. Am. Statist. Assoc.</i>	9.5	9	0 to 24
3	<i>Ann. Math. Statist.</i>	9.0	9	0 to 19
4	<i>Biometrika</i>	8.8	10	2 to 20
5	<i>Psychol. Bull.</i>	7.1	10	2 to 15
6	<i>Biometrics</i>	6.6	10	2 to 19
7	<i>Educ. Psychol. Measmt.</i>	4.9	8	0 to 14
8	<i>Brit. J. Statist. Psychol.</i>	3.5	9	0 to 7
9	<i>Psychol. Rev.</i>	1.7	8	0 to 5
10	<i>J. Roy. Statist. Soc. Ser. B</i>	1.1	7	0 to 3

During the period of review a rather astounding number of statistics books were published, many of which are of great significance to psychologists. Revised editions appeared of introductory texts by Garrett (63), Edwards (48), and Walker & Lev (153). These three books may well be challenged by Sender's *Measurement and Statistics* (132), in which an attempt was made to organize statistical methods in terms of scales of measurement and to present for the first time in a text for psychology students an elemen-

¹ The survey of the literature pertaining to this review was completed in May, 1959.

tary account of the application of information theory in statistical analysis. Just as recent texts have begun the routine inclusion of nonparametric methods, we may now anticipate another "new look" in statistical techniques deriving from the Shannon-Wiener conception of information. The recent book by Kullback (93), although too mathematical for most psychologists, will have a strong influence in this direction. See also the article by Blyth (12) for discussion of an information measure of dispersion, as compared with variance.

The books by Maxwell (109) and Cox (33) should serve as excellent collateral reading in courses emphasizing problems of experimental design and for the researcher who wishes to catch up on modern conceptions. Students of experimental design will also find much of interest in the compilation edited by Chew (24), while investigators using sampling survey methods will welcome the rich contribution of Stephan & McCarthy (138). The account by Haggard (81) relating intraclass correlation to analysis of variance, reliability studies, and pattern analysis provides many unique insights not available elsewhere. An extremely important book that unquestionably will be a classic in the methodological literature is *Theory and Methods of Scaling* by Torgerson (145), which contains material of interest both at introductory and more advanced levels.

A lucid account of the concepts underlying statistical decision theory was presented by Chernoff & Moses (23). Other books worthy of note were those by Acton (1), Anderson (3), Fraser (55), and Quenouille (121), as well as the first volume of a projected three-volume revision of *The Advanced Theory of Statistics*, authored by Kendall & Stuart (91).

A new journal, *Technometrics*, appeared in February, 1959, which, although directed primarily to the physical, chemical, and engineering sciences, promises to contain many articles of pertinence to psychological research.

CHI SQUARE

Most statistics texts for psychologists describe the use of chi square methods with respect to two-way contingency tables but do not mention the problem of extension to higher order tables. In response to an inquiry, Snedecor (134) discussed similarities and differences in conclusions which may result from application of alternative chi square techniques to a $2 \times 2 \times 2$ contingency table according to procedures suggested by Bartlett (1935), Mood (1950), and Lancaster (1951). Kastenbaum & Lamphiear (90) generalized the Bartlett method to test the hypothesis of no three-factor interaction for the general three-way contingency table. Somewhat discouraging, unless a high speed computer is available to the investigator, is the fact that the estimation of parameters for an $r \times s \times t$ table involves the solution of $(r-1)(s-1)(t-1)$ simultaneous third-degree equations. Thus a $5 \times 5 \times 6$ table produces 80 simultaneous third-degree equations in as many unknowns, and requires two hours of high speed computing time.

In dealing with the goodness-of-fit of an observed distribution to a hypo-

thetical distribution by the chi square procedure, there is always a moderate problem in deciding on the size and number of class intervals. Watson (156) devoted a long, complicated paper to this problem, concluding with the recommendation that as many class intervals as possible should be used with fairly equal subdivision of probabilities. This suggestion, although not new to mathematical statisticians, will probably surprise most psychologists who handle such a goodness-of-fit test routinely by setting up a frequency distribution with equal-sized class intervals and letting the frequencies fall as they may.

Mitra (112), in a paper on the power of the frequency chi square test in relation to costs, presented a solution for the problem of how best to allocate a budget of S dollars to a comparison of distributions from two populations, assuming it costs C_1 dollars to make an observation on population 1 and C_2 dollars to make an observation on population 2. The sampling plan which maximizes the "limiting power function" of the test with respect to alternatives violating H_0 (the probability that a random observation belongs to the j th group is equal to p_j for both sequences) is given by the ratio:

$$N_1/(N_1 + N_2) \text{ equal to } C_2/(\sqrt{C_1} + \sqrt{C_2})$$

In addition to the use of chi square methods in carrying out tests of independence and goodness-of-fit, it is well known that confidence limits for estimation of variance may also be obtained from the chi square distribution. A paper by Ramachandran (123) on the Studentized smallest chi square provides what should be a useful method for testing whether the smallest of a set of variances is significantly smaller than a criterion variance, such as the error variance in an experiment, or the variance of a control group.

MEASURES OF ASSOCIATION

Probably the most significant paper which appeared during the year in connection with measures of association was that by Kruskal (92) concerned with ordinally invariant (rank) measures. The three measures given the most attention were the so-called quadrant measure, Kendall's tau, and Spearman's rho. Of historical interest is the suggestion by the author that the quadrant measure and the essential idea of tau were first formulated by Fechner in 1897. The author concludes "on grounds of simplicity of interpretation, reasonable sensitivity to form of distribution, and relative simplicity of sampling theory" that use of tau is preferable to that of rho. Goodman & Kruskal (72) also contributed an extension of their already classical paper of 1954 on measures of association for cross classifications.

On specific measures of association, Cureton (38) presented a formula for computing the average Spearman rank correlation (rho) between a set of m independent rankings and a criterion ranking, corrected for ties in the independent rankings, and Griffin (76) described a graphic method for computing Kendall's tau. Karon & Alexander (89) discussed some limitations of

a previous suggestion by Stuart in using tau, adjusted for tied ranks, for measuring association in a contingency table where the categories are ordered. They recommend as a statistic for this purpose

$$\tau' = S/S_{\max}$$

where S is the number of pairs of objects which are in the same order in both rankings minus the number of pairs of objects in which order is reversed, and S_{\max} is the maximum value obtainable by S when agreement is perfect. It is obvious that τ' may be a useful descriptive statistic but that it does not affect the test of significance for the hypothesis that no association exists, which is based on the distribution of S as formerly.

In a similar vein, Cureton (40) suggested a descriptive statistic, ϕ/ϕ_{\max} , related to the fourfold point correlation (ϕ) but always having limits ± 1 , incorrectly noting, however, that ϕ has limits ± 1 only if all marginal proportions are .5. Again, whatever the merits of a descriptive statistic which may be useful for tasks such as item selection, nothing is gained in terms of hypothesis testing. The same may be said for the suggestion by Clemans (28) that the ratio of point biserial r to maximum point biserial r is a better index of relationship than point biserial r . Perry & Michael (118) and Perry (117) presented revised methods for obtaining confidence limits for the point biserial r , but it seems probable that most investigators will prefer to continue utilizing the means of the two groups as the basis for statistical inference. An improvement on McQuitty's index of concomitance was formulated by Geisser (64).

In a theoretical article dealing with the possible values for the mean intercorrelation among sets of paired variates, Willis (164), representing each variable by a vector in n -space, reached some very interesting conclusions, the most interesting of which was "that any number of variables may be intercorrelated negatively, on the average, albeit not highly so, unless the number of variables is quite small."

McNemar (107) proposed an ingenious method for testing whether a correlation coefficient corrected for attenuation is significantly less than unity. Two measures are obtained on each of two tests, reduced to standard score form, and then set up in a three-way analysis of variance table with three classifications based on the individuals tested (I), tests (T), and measures (M). A significant variance ratio of $I \times T$ to $I \times T \times M$ indicates that the correlation between the tests corrected for attenuation is significantly less than unity.

GENERAL PROBLEMS OF STATISTICAL INFERENCE

A number of general papers on statistical inference appeared during the year. As one of four contributors to a symposium on scientific method in psychology, Taylor (144) complained that, in psychology, statistical tests are commonly used for the "verification" of hypotheses that have apparently been subjected to little more than a cursory test of logical consistency. He

illustrated how statistical methods can "verify" absurd hypotheses, putting in a plea that the logic of verification should be considered in its entirety and that the need for nonstatistical checks should be universally recognized. Good (68) suggested some *ad hoc* methods for combining the results of several different tests of significance applied to the same data (tests in parallel) as contrasted to independent tests on different data (tests in series). In this provocative and thoroughly delightful paper, Good maintained that "Statistics is not primarily for making objective statements, but rather for introducing as much objectivity as possible into our subjective judgments . . . The notion that it must all be precise is harmful enough to be worth naming. I shall call it the 'precision fallacy.'" Fisher (53), in his continuing rejection of the rationale of statistical inference introduced by Neyman & Pearson, restated his arguments against the method of confidence intervals.

Psychologists will be interested to learn that a debate has been going on in the neighboring field of sociology about whether tests of significance can be validly applied in survey research when randomization is not carried out. Since a great deal of research in psychology does not involve the random assignment of subjects to treatment groups, many psychologists may wish to review the pros and cons of the debate; the most recent paper, by McGinnis (104), provides references and takes the sensible position that tests of significance are applicable.

Bolles & Messick (14,15) suggested that it would be worth while to supplement significance tests with indices of utility, since in many cases rejection of a null hypothesis is of little practical or theoretical utility. Their main illustration of such an index was offered in terms of the ratio of the sum of squares associated with a particular source of variation to total sum of squares in elaboration of analysis of variance. Gaito (60) criticized the Bolles-Messick index on a number of grounds, and suggested that a more defensible method is offered by analysis into components of variance. It may be appropriate to note that the Bolles-Messick objective is complicated by the variation in underlying models for analysis of variance and problems in selection of appropriate error terms, and to suggest that in many instances, if the experimenter is interested primarily in testing for particular magnitudes of difference among means, his hypotheses should be so stated and power considerations should be involved.

It should be noted for the record that an article by Goldfried (67) was added to the already overlong series which have appeared in psychological journals devoted to the topic of one-tailed vs. two-tailed tests of significance. It may be of interest to note that in none of the articles on the one-tail vs. two-tail question has it been pointed out that the specification of a critical region, say at the 5 per cent level, does not require that the region of rejection be either entirely at one tail of the sampling distribution or split equally between the two tails. In some instances the investigator may choose, for example, to distribute the critical region unequally between the two tails. A very significant paper in this connection appeared during the

year. Ramachandran (122) noted that the usual equal-tail area F -test for equality of two independent variances does not have the property of monotonicity (monotonic increase in the power of the test as the ratio of population variances diverges from equality) and is biased unless $n_1 = n_2$. Ramachandran then described and illustrated a new F' -test which has the desired property of monotonicity and unbiasedness.

Papers on problems of sampling rarely appear in psychological journals and this year was no exception, since none was located. Attention may be called to a procedure by Jones (86) on the use of confidence limits to reject unsatisfactory samples, and papers by Fisher (54) and Dalenius & Hodges (41) on stratified sampling.

Opponents of statistical methods and journal editors should be delighted with the article by Sterling (139) on a possible relationship between tests of significance, what gets published, and misinformation. Reviewing four psychology journals over a period of a year, Sterling found that, of 362 research reports, 294 (81 per cent) used tests of significance. Of the articles using such tests, over 97 per cent rejected the null hypothesis, while no reports were published which were repetitions of previously published experiments. Tentative conclusion: the literature in many fields (including fields other than psychology) may consist in substantial part of false conclusions resulting from errors of the first kind in statistical tests of significance.

EXPERIMENTAL DESIGN AND ANALYSIS OF VARIANCE-COVARIANCE

The concept of the power of a statistical test is familiar to research psychologists, but it is still a relatively rare occurrence for power considerations to enter explicitly in the planning of experiments, particularly with respect to specification of the size of samples. Perhaps the major problem in this connection for theoretical, as contrasted to applied, e.g., industrial, research is the designation of specific alternatives to be guarded against. This is difficult enough even for t -tests and in the case of a larger number of treatment groups the difficulty is accentuated. On the other hand, even for investigators who wish to estimate how many observations they should use per treatment group in order to obtain a specified power against an alternative hypothesis, the available tables and charts (Tang, Lehmer, etc.) do not easily lend themselves to such use. Based on recomputation of Lehmer's tables and the charts of Pearson & Hartley, Feldt & Mahmoud (50, 51) provided power function charts directly useful for specification of subgroup N involving two to five treatments, selected power values from .5 to .95, and levels of significance .05 and .01. Bulmer (19) described a method for determining a confidence interval on the "distance" of the true hypothesis from the null hypothesis which should be useful when "one wants to know how good an approximation to the truth the null hypothesis is."

Another variation of experimental design which is familiar to psychologists, but which, similarly, has been given minimal application, is sequential sampling methods aimed at providing savings in required numbers of ob-

servations for testing hypotheses. Birnbaum (9) elaborated on sequential methods for variance ratios and tests of variance components in analysis of variance, which should prove useful to the enterprising investigator.

The experimental design which received the greatest amount of attention during the year was the Latin square and some of its variations. Gaito (58) reviewed problems associated with counterbalanced designs, emphasizing the importance of randomization of treatments and the advantages of the Latin-square design. Gaito (59) also presented a systematic analysis of the effects on F -tests of various patterns of interaction in the Latin-square design, assuming fixed, mixed, and random variates models. He concluded that more F -tests are unbiased as more random variates are included and, as has been claimed previously by several writers, that F -test bias, when present, usually is negative so that conclusions tend to be "conservative."

Most Latin-square designs used in psychological research involve exposing subjects to more than one treatment, and there is always the possible complication of sequential effects (practice, transfer of training, fatigue, etc.). Bradley (18) described and illustrated a procedure for constructing squares having an even number of cells on a side in which immediate sequential effects may be counterbalanced by having each treatment preceded by a different treatment in every row or column, or both. Rather than attempting to handle possible sequential effects by such counterbalancing and running the risk of possible distortion of the error term, methods have also been introduced in which not only the direct but also the residual effects of treatment are estimated in designs utilizing the Latin-square principle. References to such methods are included in a paper by Patterson & Lucas (116) in which special emphasis is given to a class of "extraperiod" designs that repeat the treatment pattern of the usual last period for the purpose of estimating direct and first residual effects. D. R. Cox (34) contributed to clarification of the same problem area by discussing the conditions under which nonadditivity in the Latin square, i.e., treatment effects vary from unit to unit, may be handled for specified hypotheses about treatment contrasts. C. P. Cox (31) approached the same general problem by showing the possible advantage of replacing the nontreatment classification, e.g., successive periods, by analysis of individual regressions. Since this method allows for testing of heterogeneity among the individual regressions, it should be very useful for judging when the usual method of analyzing the Latin square is likely to give questionable results. C. P. Cox (32) also described the individual regression approach to the problem of repeated measurements, particularly for the case where there are two treatments per individual. The use of variance and covariance analysis in factorial experiments where several treatments are applied to groups of subjects over a period of time was also described by Leech & Healy (96).

A design, commonly employed by psychologists, in which repeated measurements occur is the situation where k treatments are each applied to individuals in two or more independent subgroups, where the subgrouping is

based on either a descriptive variable, e.g., diagnostic group or social class, or a variation in experimental conditions. The usual methods of analyzing this "split-plot" type of design appeared in Edward's *Experimental Design in Psychological Research* (1950) and was analyzed in more detail in Lindquist's *The Design and Analysis of Experiments* (1953) as his Type I Mixed Design. It is heartening to note that Geisser & Greenhouse (65) concluded, after a rather complex theoretical analysis, that the usual method is reasonably defensible and yields "conservative" F -tests. Collier (29) elaborated further on this kind of design, indicating alternative procedures, depending on assumptions made about the expected correlation among observations.

Of interest to experimenters is the discussion by Freeman (56) of situations in which the same subjects are used in a succession of experiments. Here, again, the first consideration is whether any effects of a prior experiment remain when a second set of treatments is applied. The main body of Freeman's paper was concerned with situations in which residual effects are likely and the form of analysis depends upon the absence or presence of interaction effects.

New forms of potentially useful experimental designs appear frequently in the statistical literature, but are only infrequently adopted for experimental research in psychology, where, by and large, there is a preference for avoiding the complications of incomplete blocks, lattice designs, and the many other variations which have been developed, for example, in experimental agronomy. One innovation which, however, may be of interest is the so-called "staircase design" introduced by Graybill & Pruitt (73) as an extension of the randomized blocks design. Suppose, for example, an experimenter wishing to study k treatments finds that his homogeneous groups, e.g., blocks made up of littermates, have varying numbers of experimental units, the maximum number of units being $N=k$. He ranks the k treatments in order of importance, $T_1, T_2 \dots T_k$, and randomizes all k treatments in the blocks containing $N=k$ units. To blocks containing N_1 units ($N_1 < k$) he assigns the first k_1 treatments, the process continuing until all blocks are used. This design thus maximizes the number of replications for treatments regarded as most important.

The use of concomitant variables to improve the precision of treatment comparisons was reviewed by Feldt (49) in terms of the three most common techniques employed: (a) stratification in terms of the covariate and use of a factorial design; (b) analysis of covariance; and (c) analysis of variance of difference scores. Feldt concluded that the most "prudent" design is stratification, if necessary data are available before the experiment is initiated. The author based his conclusions upon comparative precisions and the assumption that interactions in a factorial design are less troublesome than heterogeneity of regression. Over and above significance tests, however, he neglected to consider the greater potential information about the structure of the experiment available from covariance methods.

In recent years, a great deal of attention has been paid in statistical

circles to the problem of following up a "significant" over-all analysis of variance with appropriate comparisons of individual means. For the first time in a psychological journal an attempt was made by Ryan (128) to review the major considerations and complications which beset what has been called the problem of multiple comparisons or contrasts. Ryan's paper should dispel any lingering notion that usual *t*-tests are appropriate. Interestingly, Ryan was not satisfied with presentation of alternative possibilities and their comparative merits but appears to have been unduly influenced by an unpublished paper by Tukey (1953). Since this is a controversial topic and Ryan made a large number of controversial assumptions (e.g., comparisons decided upon a priori should not affect significance tests and lack of independence of *t*-tests is a relatively minor consideration) it seems likely that this paper will be followed by a number of rejoinders, reminiscent of the inexhaustible one-tailed vs. two-tailed controversy. This is probably a healthy state of affairs, however, indicating clearly that statistical inference is far from being a mechanical task. Halperin & Greenhouse (83), for example, chose to extend Scheffé's multiple comparison procedure to adjusted means in covariance analysis, rejecting several other approaches to multiple contrasts for this problem.

In some situations the investigator may be particularly interested in choosing the best (or worst) among several "normal" populations. Bechhofer (7) and Zinger & St-Pierre (167) have contributed "solutions" to decisions of this kind.

Several excellent papers by Glenn & Kramer (66) and Wilkinson (160, 161) appeared, which were devoted to the analysis of variance of various experimental designs when one or more observations are missing.

NONPARAMETRIC METHODS

Several nonparametric or distribution-free techniques have already been mentioned in preceding sections on chi square and measures of association. Actually the number of new suggestions for nonparametric procedures was relatively small during the year. Among these were a test by Sukhatme (143) for comparing the "variances" of two samples and a bivariate sign test by Blumen (11) in which slopes of vectors from the bivariate median are ordered to yield a test of whether the medians of two sets of paired differences have a particular value, e.g., zero. Dunn (46) also used a ranking method for arriving at joint confidence intervals for the medians of a bivariate population. These two latter procedures are in addition to the suggestions made by Silverstein (133) on use of familiar nonparametric methods for comparison of changes in an experimental group with changes in a control group.

Barton, David & Mallows (6) provided a test for randomness in a sequence of two alternatives by means of paired comparisons. This test is appropriate in situations such as the following: a judge is given photographs of N_1 men and N_2 women and instructed to arrange them in order of age. Actually the persons in the photographs are all of the same age. The inves-

tigator wishes to test a null hypothesis of randomness because he theorizes that judges will show an "unconscious" bias to consider women of lower (or higher) age. Goodman (70) also described a "runs" test for randomness in a sequence consisting of two or more alternatives which reduces to simplified tests similar to tests of independence in contingency tables.

What appears to date to be the simplest and quickest test for comparing two independent samples was formulated by Tukey (149): if one group contains the highest value and the other the lowest value, sum the number of values in the first group exceeding all values in the second group together with the number of values in the second group falling below all values in the first group. If the groups are roughly of the same size, the critical value of the total count is 7 for a two-sided 5 per cent level, 10 for a two-sided 1 per cent level, and 13 for a two-sided 0.1 per cent level.

In terms of elaboration on available nonparametric methods, McNemar (106) again attacked the much belabored Wilson median test for analysis of variance, Wallace (154) provided some simplified approximations to the Kruskal-Wallis one-way analysis of variance of ranks, and Birnbaum & McCarty (10) extended the Mann-Whitney procedure to the determination of confidence intervals and estimation of sample sizes required for specified intervals. Walsh (155) rejected the prevalent notion that his median tests are essentially the same as the Wilcoxon signed-rank test, claiming that his methods are more efficient and have a wider range of applications. Tables for determining nonparametric tolerance limits, e.g., values of $m=r+s$ such that one may assert with specified confidence that a given percentage of a population lies between the r th smallest and the s th largest of a random sample, were furnished by Somerville (136).

The practical issues of when to use nonparametric techniques rather than classical methods such as the t -test, analysis of variance, correlational analysis, etc., are still unsettled and will not be settled in this review. On the one hand, there is a camp of ardent nonparametricists who, at the extreme, argue for almost the complete rejection of classical methods in analysis of psychological data. In opposition there is a camp of neoclassicists who point with pride to accumulating evidence about the "robustness" of classical methods, i.e., statistical inferences based on assumptions such as normality tend to be relatively unaffected even by fairly wide violations of assumptions. For example, on the basis of reviewing the literature beginning with the classic work of Pearson & Adyanthaya in 1929 and including an elaborate empirical investigation and theoretical analysis of his own, Srivastava (137) concluded that "for practical purposes, the power of the t -test is not seriously invalidated even if the samples are from considerably non-normal populations." Welch (157) traced the history of the t -test, on the other hand, and concluded that the t -test may have advantage over large sample theory only if the sampling is from a near-Gaussian population.

Cox (37) noted that it may be argued that, even if there is no good reason for expecting a normal population, we should not be willing to accept the

distribution-free conclusions unconditionally. He granted, however, that such methods are "often very useful in small sample situations where little is known about the population form and where elaborate treatment of results would be out of place." Gaito (61) suggested that nonparametric techniques be given limited usage, primarily as screening devices or when there are extremely gross deviations from assumptions.

It seems pertinent to note that, by and large, mathematical statisticians do not include assumptions about type of scale *à la* Stevens in their discussions of the relative merits of nonparametric vs. classical methods. It is a crucial but still open issue as to whether variables must be demonstrable as measurable by at least an interval scale for valid use of classical methods. Gaito (61) wondered, for example, whether the interval scale assumption does not really reduce to the relatively flexible normal distribution assumption "no matter what the formal scale properties of the scale." Even Mosteller (113), whose influential chapter with Bush on "Selected Quantitative Techniques" in the *Handbook of Social Psychology* (1954) presented a strong case for the adoption of nonparametric methods, stated: "But when I do not know exactly what kind of scale I have, for instance, I may have nearly an interval scale in the test score case, it seems sensible to use the statistics appropriate to the type of scale I think I am near." Mosteller spoke further about the "importance of a slightly soft theory," feeling that "we should not too lightly abandon a statistical method because we cannot assure ourselves that we do have exactly an interval or ratio scale."

The reader cannot help but have noted that in almost all of the sources cited there was criticism of the wholesale or uncritical replacement of classical methods by nonparametric techniques. The reviewer is also cautious about throwing out classical methods in psychological research, basing his bias chiefly on their more extensive utility and the remarkably rapid potency of the central limit theorem, which, paradoxically, is so commonly invoked by nonparametricists for normal approximations to their procedures when the N goes over 10 or 15. As an antidote to this prejudice on the reviewer's part, however, it is only fair to note the article by Sawrey (130) and, especially, the paper by Bush (20) and the statistics text by Senders (132), which are nonparametrically and scale-of-measurement oriented to the highest degree.

BIVARIATE AND MULTIVARIATE ANALYSIS

Since many statistics books for psychologists do not mention it, it may be that many psychologists are not aware of the fact that in the usual method of fitting the linear regression equation, $Y = \alpha + \beta X$, it is assumed that the X s are fixed values, i.e., measured without error. Many mathematical statisticians are critical of the naive way psychologists apply the usual procedure when it is obvious that both X and Y are subject to error. A thorough review of this subject by Madansky (108), which includes some 15 different methods of estimating β , is guaranteed to dispel any illusion that fitting a

regression line of Y on X is a simple, straightforward process in such cases. The practical investigator, after being exposed to the difficulties described by Madansky, may even wish to retreat to the "quick" estimate of the regression coefficient, based on ordering the X s, described by Barton & Casley (5).

Several other papers on regression problems should be of interest to psychologists. Williams (162) discussed applications of simultaneous regression equations in experimental work, such as the calibration of instruments, and concluded that, in many cases dealt with by discriminant functions, the set of regression equations is more informative. Cox (35, 36) described regression analysis methods when the dependent variable can take only two values, say 0 and 1. He illustrated with the example of a learning study in which a task is attempted a number of times in succession and the primary observation is success or failure at each trial. The investigator wishes to examine the dependence of the probability of success on such variables as number of preceding trials, number of previously rewarded successes, etc.

In some situations one may seek to determine whether the parameters of a linear regression system switch at a particular point in time from one set of values to another. Quandt (120) formulated such a method in the context of economic research, but his approach may be of use in psychological research, such as longitudinal studies. Other papers of interest concerned the use of linear programming methods in regression analysis by Wagner (152), ratio-type estimators and their relation to regression techniques by Goodman & Hartley (71), and the fitting of exponential regression curves by Finney (52) and Patterson (115).

Outside of the very significant book by Anderson (3), little by way of publication was directly concerned with problems of differential selection and classification. Pickrel (119) summarized the current state of affairs in a very readable review, noting the availability of the multiple discriminant function, the multiple cutting score, the unique pattern method, and multiple regression. Galler (62) illustrated how a linear program model might be applied to a classification problem of a familiar variety, if a high speed computer is available. Baker (4) developed a test for detecting whether a sample of observations comes from a population composed of more than one normal distribution, a question relevant to subsequent classification. In a paper which should be pertinent for some aspects of profile analysis, Scheffé (131) dealt with the problem of predicting the response to a mixture of q components when the response depends only on the relative proportions of the components and not on the total amount. The difficulty of working out satisfactory solutions for complex classification problems is illustrated in the complicated theoretical paper by Wesler (158) on the "problem of the k -faced die," which dealt with such questions as which of the faces of a die carries a known extra load, or is a die loaded? Bechhofer, Elmaghraby & Morse (8) also dealt with this problem, coming up, for example, with the

rather astounding estimation: if one of 36 numbers on an unbalanced roulette wheel occurs 10 per cent more frequently than the next most frequent number, an observer wishing to pick the "winner" with a probability of at least .90 of being correct would have to take at least 47,342 observations!

It is common practice for psychologists to make observations on many variables when comparing two groups of cases. Although the classical multivariate two-sample significance test is based on Hotelling's T^2 , it is far more common for investigators to draw conclusions by carrying out a dubious series of t -tests or critical ratios for each variable at a time. Unfortunately the T^2 statistic is not applicable when the number of variables is greater than the number of within-group degrees of freedom, although there is great need for some such method for dealing with the practical problem of what might be called "overdetermined" cases. Chung & Fraser (25) suggested several randomization and nonparametric methods for handling this problem, making the questionable assumption, however, that the variables are independent. The "distance" solutions suggested by Dempster (43) appear to be somewhat more promising, being more in accord with the classical T^2 method and making the less stringent assumption that the two populations have the same structure of variances and covariances.

An even more complex problem arises when a single group or matched groups are measured on R -variables on two or more occasions. Dunn (45) provided methods for constructing "simultaneous" confidence intervals for means of R dependent variables, e.g., the mean responses of N individuals to R different levels of a stimulus. Roy & Potthoff (126) dealt with the problem of determining confidence bounds for the multivariate extension of ratios of means and variances in the two sample case, e.g., comparison of several characteristics of a set of individuals before and after a treatment.

In many investigations, data are based on noting the presence or absence of specified responses, or "signs," for each of a group of cases. For example, if there are three signs, each of which is scored "yes"-"no," a total of 2^3 or 8, patterns is possible. Frequently, such results are arbitrarily reduced to univariate form by counting or pooling of categories. Claringold (26) described how such data may be handled by what he calls "multivariate quantal analysis."

FACTOR ANALYSIS

While chairing a symposium on *The Future of Factor Analysis*, Michael (110) noted four principal directions that factor analysis appeared to be taking. Briefly, these are: (a) greater objectivity in determination of number of factors, definition of simple structure, and estimation of communalities, as well as demonstration of invariance; (b) closer relations between factor analytic models and psychological theory; (c) increased use of factor analytic procedures in test development and criterion analysis; and (d) more utilization of inverted factor analysis and other techniques, such as those suggested by Cattell, in the areas of personality, social psychology, and clinical in-

vestigation. In the same symposium, Guttman (80) emphasized the need for *rapprochement* of factor analysis, factorial analysis of variance designs, and psychological theory; he illustrated briefly in terms of his radex theory. The only general paper on factor analysis which was noted during the year was that of Jowett (87). Most publications were devoted to one or the other aspect of Michael's "principal directions," noted above.

The push toward greater objectivity stressed by Michael (110) and Wrigley (165) was well evidenced during the year, especially in reference to continuing attempts to develop and "test" analytic methods of rotation serviceable by high speed computers. After comparing the "quartimax" method of rotation of centroid factor loadings with several other methods, Wrigley & Saunders (166) suggested that this method is sufficiently good to justify its use in the first stages of rotation. Kaiser (88) reviewed the history of efforts to formulate analytic methods of rotation and presented the details of his "varimax" criterion for rotation. At the same time he suggested that factorial invariance rather than simple structure be the ultimate criterion of rotational procedures. Sokal (135) described and illustrated what he called a "mass modification" of Thurstone's analytical method for simple structure. Fruchter & Novak (57), also noting the trend toward objectivity, compared three methods of rotation, including the Thurstone analytic technique, and found different advantages for each method.

An ingenious contribution to the problem of factorial invariance was made by Tucker (148) in his interbattery method of factor analysis. In this method, two different batteries of tests, postulated to depend on the same factors, are given to a group of individuals. The correlations of the tests in one battery with those in the second battery are used for the primary factor analysis, thus avoiding the controversial problem of estimating communalities. The correlation matrices of the two separate batteries are then used to carry out statistical tests of the factors and to estimate coefficients of factor reliability.

Both Guttman (79) and Cattell (22) offered similar and somewhat iconoclastic suggestions about the "rank of the matrix" problem, loosely translated as determining the number of common factors underlying a set of correlations. Guttman indicated that the appropriate null hypothesis should be that the number of common factors is large (rather than small), while Cattell postulated that the aim of factor analysis is to find the largest number of "real" factors operating in the given sample. Incidentally, in the same article, Cattell also went against the trend toward "objectivity" in estimating communalities, rotating, etc., speaking of the need for "craftsmanship and skill." Some doubt was cast on the rather extensive effort that has been made in recent years to solve the problem of estimation of communalities in a study by Tyler & Michael (150), which indicated negligible distortions of factor structure when unities were substituted for communality estimates in several matrices.

Lawley (94) investigated numerical solutions of maximum likelihood equations for estimation of factor loadings when the number of factors, as well as specified zero loadings, is assumed in advance.

Tryon (147) provided a brief but charming history of factor analysis which he would prefer to call "dimension analysis." He criticized "Thurstonian orthodoxy" on several grounds, e.g., "rotation is arduous, subjective and an art," and proclaimed that cluster analysis is simpler, more effective, and better suited to make inferences as to "causal components." Tryon (146) also furnished technical details on his method of cumulative communality cluster analysis, making use of his recently developed procedure for estimating communalities as well as his "principles of domain sampling." A method of hierarchical factor solution which achieves simple structure without rotation was presented by Wherry (159). Haggard *et al.* (82) attempted to show how intraclass correlation methods may be useful as a kind of substitute factor analysis for the uninitiated investigator.

The unsettled state of factor analytic methods as tools for multivariate analysis is thus as evident as ever. In the context of criticizing Guttman's simplex theory as a psychological model, Borgatta (16) came to a conclusion that would not have startled Spearman: "It is possible that a more systematic approach to ordering the correlation matrix may be as important a means of analyzing the data as cluster or factor analysis, especially for small tables."

PSYCHOMETRICS, SCALING, AND TESTING

Stevens (140) reviewed the problems and methods of psychophysics, offering a very useful classification of major "parameters" in terms of (a) the task of the judge (classification, order, intervals, ratios, magnitudes), (b) stimulus arrangement (fixed, adjustable), and (c) statistical measure (location, variability). Mosteller (113) spoke of the "mystery of the missing corpus," i.e., where is the theory relating psychometric methods with each other and with physical continua? Luce & Edwards (102) also pondered about the relations among various psychophysical methods while noting that Fechner's method for adding just noticeable differences to obtain sensory scales is in error. A new psychophysical method called the method of transposition, or equal-appearing relations, was described by Oyama (114).

Several articles were devoted to the method of paired comparisons. Gulliksen & Tukey (77) formulated a threefold variance-component model for paired comparisons, showing how the model could lead to various statistical tests, while a somewhat different three-component model, aimed at accounting for correlation of errors, was postulated by Bock (13). Gulliksen (78) suggested that the quantity, $\sqrt{\sigma_i^2 + \sigma_j^2 - 2r_{ij}\sigma_i\sigma_j}$, based on the Law of Comparative Judgment, be termed the "comparatal dispersion" and used as a measure of accuracy of judgment. In a study using paired comparisons for scaling intensities of taste stimuli, Griggeman (75) utilized logit analysis

and discussed the relationship of this method to standard psychophysical methods. Dykstra (47) described how Scheffé's analysis of variance procedure for paired comparisons may be usefully combined with factorial experimental design.

Adams & Messick (2) turned their attention to the method of successive intervals, presenting a set of axioms and consequences, which were generalized to nonnormal stimulus distributions. The only article noted that dealt with multidimensional scaling was an important paper by Coombs (30), who described and illustrated a nonmetric method for measuring similarity of stimuli based on rank ordering of distances between points in r -dimensional space. Roberts (125) extended procedures for assessing chance frequency in matching problems to the case where n different objects are to be matched with n different categories and the judge is informed of his success or failure after each matching.

The rationale and alternative procedures for determining and testing coefficients of reproducibility in scalogram analysis of dichotomous items were discussed by Sagi (129) and Goodman (69). Both authors stressed the frequently neglected caution that such coefficients are not applicable to sets of items that have already been "purified." A machine method for computing Guttman's coefficient of reproducibility was described by Heath (84). Criteria for testing the homogeneity of a set of nondichotomous items in attitude measurement were formulated by Jardine (85).

The Q-sort technique was modified by Reznikoff & Toomey (124) to provide a measure of location as well as pattern.

Very few papers on item analysis actually appeared during the year. Du Mas (44) complained that tests scored in usual ways waste a tremendous amount of information; he predicted that when configural analyses have been adequately developed, tests composed of very few items will do a better job than current tests with large numbers of items. Along this line, Stewart (141) described an International Business Machines procedure of cumulative pattern analysis for adding the next best item to a pool of items when there is an external criterion. In the absence of an outside criterion, Lawshe & Harris (95) reintroduced the iterative method of reciprocal averages formulated by Richardson & Kuder in 1933 for optimal weighting of items in relation to total summation of responses.

Some further suggestions were made by Willingham & Jones (163) for the application of analysis of variance procedures to the study of judgment error, particularly "halo" effects, as an extension of methods presented in Guilford's 1954 edition of *Psychometric Methods*. Russell & Bradley (127) indicated how judge consistency may be assessed by tests of homogeneity of variance in randomized blocks designs.

The only general paper on test reliability to appear during the year was by Cureton (39), who showed how the major methods of estimating reliability may be derived by defining the reliability coefficient as the variance ratio

of true scores to total scores on a single form of a test. Cureton also included a thoughtful discussion of problems of constructing equivalent forms and sources of unreliability, such as sampling of items, occasions, and judges.

Lyerly (100, 101) showed that the Kuder-Richarson Formula 21 reliability coefficient can be derived as a generalized split-half Spearman-Brown coefficient, and subsequently provided a chi square formula and table for assessing its significance. Lord (97) specified the relationship between Guttman's principal components of scale analysis and maximization of the Kuder-Richardson Formula 20 reliability coefficient. Formulas for determining the standard error of measurement of the difference between a sum score and one of its parts were provided by Davis (42).

McNemar (105) criticized and simplified previous suggestions by Lord for using regression methods to measure growth or gains, while Lord (98) added a further paper on the measurement of growth as well as an article on the estimation of true scores from observed scores (99).

Problems of validity and validation received minimal attention during the year. One exception was the thought-provoking discussion by Campbell & Fiske (21) of the sensible position that validation of particular methods for measuring particular traits should be based on the expectation that higher correlations should be found among measures of the same trait by different methods than among different traits by the same method. Campbell & Fiske compared their approach with formulations of construct validity, a topic which was thoroughly reviewed by Clark (27).

On the empirical side, McCornack (103) compared the classical method of cross-validation with double cross-validation in developing scoring keys for the Strong Vocational Interest Blank, but with equivocal results, while Stuckert (142), in a study of the prediction of scholastic success, found that a method of predicted configurations derived from Guttman's conceptions of manifold classification appeared to be superior to multiple regression or unit weighting methods. In an issue of the *Review of Educational Research* devoted to "Educational and Psychological Testing," Michael (111) provided an excellent three-year survey of recent statistical methods useful for test construction and evaluation.

HIGH-SPEED COMPUTERS

The association between high-speed computers and proliferation of factor analysis methods has been publicized so much in recent years that many psychologists may not be aware of the frequently efficient role that computers can play in more routine statistical operations. Borgatta & Robbin (17) noted, for example, their usefulness for item analysis, Guttman scaling, *t*-tests, and analysis of variance, as well as factor analysis, in a balanced discussion of the implications of high-speed computers for the methodology of social research. Vandenberg (151) also discussed some of the potential benefits, as well as dangers, entailed in the increasing use of elec-

tronic computers, while Green (74) described some noncomputational uses of digital computers, such as their ability to generate a random sequence of events relevant to determination of the properties of a statistical model. The latter two papers appeared in a newly established section (1959) on use of electronic computers in *Behavioral Science*.

We are living in a curiously ambivalent statistical world where emphasis is being given, on one hand, to development of quicker and quicker, almost assumption-free, techniques which the investigator can carry in his head, e.g., Tukey (149), while at the same time facilities are available to carry out lengthy and complex computations not considered practical a few years ago. One can only hope that the marvelous opportunities for "trying everything" offered by high-speed computers will not see the day when investigators will spend more time trying to interpret results of trial and error manipulation of data than theorizing, planning, and carrying out research.

LITERATURE CITED

1. Acton, F. S. *Analysis of Straight-Line Data* (John Wiley & Sons, Inc., New York, N. Y., 267 pp., 1959)
2. Adams, E., and Messick, S. An axiomatic formulation and generalization of successive intervals scaling. *Psychometrika*, **23**, 355-68 (1958)
3. Anderson, T. W. *An Introduction to Multivariate Statistical Analysis* (John Wiley & Sons, Inc., New York, N. Y., 374 pp., 1958)
4. Baker, G. A. Empiric investigation of a test of homogeneity for populations composed of normal distributions. *J. Am. Statist. Assoc.*, **53**, 551-57 (1958)
5. Barton, D. E., and Casley, D. J. A quick estimate of the regression coefficient. *Biometrika*, **45**, 431-35 (1958)
6. Barton, D. E., David, F. N., and Mallows, C. L. Non-randomness in a sequence of two alternatives. *Biometrika*, **45**, 166-80, 253-256 (1958)
7. Bechhofer, R. E. A sequential multiple-decision procedure for selecting the best one of several normal populations with a common unknown variance, and its use with various experimental designs. *Biometrics*, **14**, 408-29 (1958)
8. Bechhofer, R. E., Elmaghraby, S., and Morse, N. A single-sample multiple-decision procedure for selecting the multinomial event which has the highest probability. *Ann. Math. Statist.*, **30**, 102-19 (1959)
9. Birnbaum, A. Sequential tests for variance ratios and components of variance. *Ann. Math. Statist.*, **29**, 504-14 (1958)
10. Birnbaum, Z. W., and McCarty, R. C. A distribution-free upper confidence bound for $\Pr\{Y < X\}$, based on independent samples of X and Y . *Ann. Math. Statist.*, **29**, 558-62 (1958)
11. Blumen, I. A new bivariate sign test. *J. Am. Statist. Assoc.*, **53**, 448-56 (1958)
12. Blyth, C. R. Note on estimating information. *Ann. Math. Statist.*, **30**, 71-79 (1959)
13. Bock, R. D. Remarks on the test of significance for the method of paired comparisons. *Psychometrika*, **23**, 323-34 (1958)
14. Bolles, R., and Messick, S. Statistical utility in experimental inference. *Psychol. Repts.*, **4**, 223-27 (1958)
15. Bolles, R., and Messick, S. Statistical utility and components of variance. *Psychol. Repts.*, **4**, 714 (1958)
16. Borgatta, E. F. On analyzing correlation matrices: some new emphases. *Public Opinion Quart.*, **22**, 516-28 (1958)
17. Borgatta, E. F., and Robbin, J. Some implications of high speed computers for the methodology of social research. *Sociol. Social Research*, **43**, 259-64 (1959)
18. Bradley, J. V. Complete counterbalancing of immediate sequential effects in a Latin square design. *J. Am. Statist. Assoc.*, **53**, 525-28 (1958)
19. Bulmer, M. G. Confidence intervals for distance in the analysis of variance. *Biometrika*, **45**, 360-69 (1958)
20. Bush, R. R. The new look in measurement theory. In *Use of Judgments as Data in Social Work Research*, 89-96 (Shyne, A. W., Ed., National Association of Social Workers, New York, N. Y., 105 pp., 1958)
21. Campbell, D. T., and Fiske, D. W. Convergent and discriminant validation by the multitrait-multimethod matrix. *Psychol. Bull.*, **56**, 81-105 (1959)
22. Cattell, R. B. Extracting the correct number of factors in factor analysis. *Educ. Psychol. Measurement*, **18**, 791-838 (1958)

23. Chernoff, H., and Moses, L. *Elementary Decision Theory* (John Wiley & Sons, Inc., New York, N. Y., 364 pp., 1959)
24. Chew, V. *Experimental Designs in Industry* (John Wiley & Sons, Inc., New York, N. Y., 268 pp., 1958)
25. Chung, J. H., and Fraser, D. A. S. Randomization tests for a multivariate two-sample problem. *J. Am. Statist. Assoc.*, **53**, 729-35 (1958)
26. Claringold, P. J. Multivariate quantal analysis. *J. Roy. Statist. Soc., Ser. B*, **20**, 398-405 (1958)
27. Clark, C. A. Development and applications in the area of construct validity. *Rev. Educ. Research*, **29**, 84-105 (1959)
28. Clemans, W. V. An index of item-criterion relationship. *Educ. Psychol. Measurement*, **18**, 167-72 (1958)
29. Collier, R. O., Jr. Analysis of variance for correlated observations. *Psychometrika*, **23**, 223-36 (1958)
30. Coombs, C. H. An application of a nonmetric model for multidimensional analysis of similarities. *Psychol. Repts.*, **4**, 511-18 (1958)
31. Cox, C. P. The analysis of Latin square designs with individual curvatures in one direction. *J. Roy. Statist. Soc., Ser. B*, **20**, 193-204 (1958)
32. Cox, C. P. Experiments with two treatments per experimental unit in the presence of an individual covariate. *Biometrics*, **14**, 499-512 (1958)
33. Cox, D. R. *Planning of Experiments* (John Wiley & Sons, Inc., New York, N. Y. 308 pp., 1958)
34. Cox, D. R. The interpretation of the effects of non-additivity in the Latin square. *Biometrika*, **45**, 69-73 (1958)
35. Cox, D. R. The regression analysis of binary sequences. *J. Roy. Statist. Soc., Ser. B*, **20**, 215-32 (1958)
36. Cox, D. R. Two further applications of a model for binary regression. *Biometrika*, **45**, 562-65 (1958)
37. Cox, D. R. Some problems connected with statistical inference. *Ann. Math. Statist.*, **29**, 357-72 (1958)
38. Cureton, E. E. The average Spearman rank criterion correlation when ties are present. *Psychometrika*, **23**, 271-72 (1958)
39. Cureton, E. E. The definition and estimation of test reliability. *Educ. Psychol. Measurement*, **18**, 715-38 (1958)
40. Cureton, E. E. Note on ϕ/ϕ_{\max} . *Psychometrika*, **24**, 89-91 (1959)
41. Dalenius, T., and Hodges, J. L., Jr. Minimum variance stratification. *J. Am. Statist. Assoc.*, **54**, 88-101 (1959)
42. Davis, F. B. The standard error of measurement of the difference between a sum score and one of its parts. *J. Educ. Psychol.*, **49**, 205-8 (1958)
43. Dempster, A. P. A high dimensional two sample significance test. *Ann. Math. Statist.*, **29**, 995-1010 (1958)
44. du Mas, F. M. Concept of the intratest and some implications for psychometric theory. *Psychol. Repts.*, **4**, 187-92 (1958)
45. Dunn, O. J. Estimation of the means of dependent variables. *Ann. Math. Statist.*, **29**, 1095-1111 (1958)
46. Dunn, O. J. Estimation of the medians for dependent variables. *Ann. Math. Statist.*, **30**, 192-97 (1959)
47. Dykstra, O. Factorial experimentation in Scheffé's analysis of variance for paired comparisons. *J. Am. Statist. Assoc.*, **53**, 529-42 (1958)

48. Edwards, A. L. *Statistical Analysis*, Revised ed. (Rinehart & Co., Inc., New York, N. Y., 234 pp., 1958)
49. Feldt, L. S. A comparison of the precision of three experimental designs employing a concomitant variable. *Psychometrika*, **23**, 335-53 (1958)
50. Feldt, L. S., and Mahmoud, M. W. Power function charts for specification of sample size in analysis of variance. *Psychometrika*, **23**, 201-10 (1958)
51. Feldt, L. S., and Mahmoud, M. W. Power function charts for specifying numbers of observations in analyses of variance of fixed effects. *Ann. Math. Statist.*, **29**, 871-77 (1958)
52. Finney, D. J. The efficiencies of alternative estimators for an asymptotic regression equation. *Biometrika*, **45**, 370-88 (1958)
53. Fisher, R. A. Mathematical probability in the natural sciences. *Technometrics*, **1**, 21-29 (1959)
54. Fisher, W. D. On grouping for maximum homogeneity. *J. Am. Statist. Assoc.*, **53**, 789-98 (1958)
55. Fraser, D. A. S. *Statistics: An Introduction* (John Wiley & Sons, Inc., New York, N. Y., 398 pp., 1958)
56. Freeman, G. H. The use of the same experimental material for more than one set of treatments. *Appl. Statist.*, **8**, 13-20 (1959)
57. Fruchter, B., and Novak, E. A comparative study of three methods of rotation. *Psychometrika*, **23**, 211-21 (1958)
58. Gaito, J. Statistical dangers involved in counterbalancing. *Psychol. Repts.*, **4**, 463-68 (1958)
59. Gaito, J. The single Latin square design in psychological research. *Psychometrika*, **23**, 369-78 (1958)
60. Gaito, J. The Bolles-Messick coefficient of utility. *Psychol. Repts.*, **4**, 595-98 (1958)
61. Gaito, J. Non-parametric methods in psychological research. *Psychol. Repts.*, **5**, 115-25 (1959)
62. Galler, B. A. Some remarks on linear programming. *Behavioral Sci.*, **4**, 167-70 (1959)
63. Garrett, H. E. *Statistics in Psychology and Education*, 5th ed. (Longmans, Green & Co., Inc., New York, N. Y., 478 pp., 1958)
64. Geisser, S. A note on McQuitty's index of concomitance. *Educ. Psychol. Measurement*, **18**, 125-28 (1958)
65. Geisser, S., and Greenhouse, S. W. An extension of Box's results on the use of the F distribution in multivariate analysis. *Ann. Math. Statist.*, **29**, 885-91 (1958)
66. Glenn, W. A., and Kramer, C. Y. Analysis of variance of a randomized block design with missing observations. *Appl. Statist.*, **7**, 173-85 (1958)
67. Goldfried, M. R. One-tailed tests and "unexpected" results. *Psychol. Rev.*, **66**, 79-80 (1959)
68. Good, I. E. Significance tests in parallel and in series. *J. Am. Statist. Assoc.*, **53**, 799-813 (1958)
69. Goodman, L. A. Simple statistical methods for scalogram analysis. *Psychometrika*, **24**, 29-43 (1959)
70. Goodman, L. A. Simplified runs test and likelihood ratio tests for Markoff chains. *Biometrika*, **45**, 181-97 (1958)

71. Goodman, L. A., and Hartley, H. O. The precision of unbiased ratio-type estimators. *J. Am. Statist. Assoc.*, **53**, 491-508 (1958)
72. Goodman, L. A., and Kruskal, W. H. Measures of association for cross classifications. II. Further discussion and references. *J. Am. Statist. Assoc.*, **54**, 123-63 (1959)
73. Graybill, F. A., and Pruitt, W. E. The staircase design: theory. *Ann. Math. Statist.*, **29**, 523-33 (1958)
74. Green, B. F. Non-computational uses of digital computers. *Behavioral Sci.*, **4**, 164-67 (1959)
75. Gridgeman, N. T. Application of quantal-response theory to the cross-comparison of taste-stimuli intensities. *Biometrics*, **14**, 548-57 (1958)
76. Griffin, H. D. Graphic computation of tau as a coefficient of disarray. *J. Am. Statist. Assoc.*, **53**, 441-47 (1958)
77. Gulliksen, H., and Tukey, J. W. Reliability for the law of comparative judgment. *Psychometrika*, **23**, 95-110 (1958)
78. Gulliksen, H. Comparatal dispersion, a measure of accuracy of judgment. *Psychometrika*, **23**, 137-50 (1958)
79. Guttman, L. To what extent can communalities reduce rank? *Psychometrika*, **23**, 297-308 (1958)
80. Guttman, L. What lies ahead for factor analysis? *Educ. Psychol. Measurement*, **18**, 497-515 (1958)
81. Haggard, E. A. *Intraclass Correlation and the Analysis of Variance* (The Dryden Press, Inc., New York, N. Y., 171 pp., 1958)
82. Haggard, E. A., Chapman, J. P., Isaacs, K. E., and Dickman, K. W. Intraclass correlation vs. factor analytic techniques for determining groups of profiles. *Psychol. Bull.*, **56**, 48-57 (1959)
83. Halperin, M., and Greenhouse, S. W. Note on multiple comparisons for adjusted means in the analysis of covariance. *Biometrika*, **45**, 256-59 (1958)
84. Heath, R. W. A machine method of computing Guttman's coefficient of reproducibility with a large sample. *J. Appl. Psychol.*, **42**, 204-5 (1958)
85. Jardine, R. Ranking methods and the measurement of attitudes. *J. Am. Statist. Assoc.*, **53**, 720-28 (1958)
86. Jones, H. L. Inadmissible samples and confidence limits. *J. Am. Statist. Assoc.*, **53**, 482-90 (1958)
87. Jowett, G. H. Factor analysis. *Appl. Statist.*, **7**, 114-25 (1958)
88. Kaiser, H. F. The varimax criterion for analytic rotation in factor analysis. *Psychometrika*, **23**, 187-200 (1958)
89. Karon, B. P., and Alexander, I. E. A modification of Kendall's tau for measuring association in contingency tables. *Psychometrika*, **23**, 379-83 (1958)
90. Kastenbaum, M. A., and Lamphiear, D. E. Calculation of chi-square to test the no three-factor interaction hypothesis. *Biometrics*, **15**, 107-15 (1959)
91. Kendall, M. G., and Stuart, A. *The Advanced Theory of Statistics. Distribution Theory*, I (Hafner Publishing Co., Inc., New York, N. Y., 433 pp., 1958)
92. Kruskal, W. H. Ordinal measures of association. *J. Am. Statist. Assoc.*, **53**, 814-61 (1958)
93. Kullback, S. *Information Theory and Statistics* (John Wiley & Sons, Inc., New York, N. Y., 395 pp., 1959)

94. Lawley, D. N. Estimation in factor analysis under various initial assumptions. *Brit. J. Statist. Psychol.*, **11**, 1-12 (1958)
95. Lawshe, C. H., and Harris, D. H. The method of reciprocal averages in weighting personnel data. *Educ. Psychol. Measurements*, **18**, 331-36 (1958)
96. Leech, F. B., and Healy, M. J. R. The analysis of experiments in growth rate. *Biometrics*, **15**, 98-106 (1959)
97. Lord, F. M. Some relations between Guttman's principal components of scale analysis and other psychometric theory. *Psychometrika*, **23**, 291-96 (1958)
98. Lord, F. M. Further problems in the measurement of growth. *Educ. Psychol. Measurement*, **18**, 437-51 (1958)
99. Lord, F. M. Statistical inferences about true scores. *Psychometrika*, **24**, 1-17 (1959)
100. Lyerly, S. B. The Kuder-Richardson Formula (21) as a split-half coefficient and some remarks on its basic assumption. *Psychometrika*, **23**, 267-70 (1958)
101. Lyerly, S. B. Significance levels for the Kuder-Richardson (21) reliability coefficient. *Educ. Psychol. Measurement*, **19**, 73-75 (1959)
102. Luce, R. D., and Edwards, W. The derivation of subjective scales from just noticeable differences. *Psychol. Rev.*, **65**, 222-37 (1958)
103. McCornack, R. L. An evaluation of two methods of cross-validation. *Psychol. Repts.*, **5**, 127-30 (1959)
104. McGinnis, R. Randomization and inference in sociological research. *Am. Sociol. Rev.*, **23**, 408-14 (1958)
105. McNemar, Q. On growth measurement. *Educ. Psychol. Measurement*, **18**, 47-55 (1958)
106. McNemar, Q. More on the Wilson test. *Psychol. Bull.*, **55**, 334-35 (1958)
107. McNemar, Q. Attenuation and interaction. *Psychometrika*, **23**, 259-65 (1958)
108. Madansky, A. The fitting of straight lines when both variables are subject to error. *J. Am. Statist. Assoc.*, **54**, 173-205 (1959)
109. Maxwell, A. E. *Experimental Design in Psychology and the Medical Sciences* (John Wiley & Sons, Inc., New York, N. Y., 147 pp., 1958)
110. Michael, W. B. An overview of the symposium on the future of factor analysis. *Educ. Psychol. Measurement*, **18**, 455-61 (1958)
111. Michael, W. B. Development of statistical methods especially useful in test construction and evaluation. *Rev. Educ. Research*, **29**, 106-29 (1959)
112. Mitra, S. K. On the limiting power function of the frequency chi-square test. *Ann. Math. Statist.*, **29**, 1221-33 (1958)
113. Mosteller, F. The mystery of the missing corpus. *Psychometrika*, **23**, 279-89 (1958)
114. Oyama, T. A new psychophysical method: method of transposition or equal-appearing relations. *Psychol. Bull.*, **56**, 74-79 (1959)
115. Patterson, H. D. The use of autoregression in fitting an exponential curve. *Biometrika*, **45**, 389-400 (1958)
116. Patterson, H. D., and Lucas, H. L. Extra-period change-over design. *Biometrics*, **15**, 116-32 (1959)
117. Perry, N. C. A revised tabulation for obtaining significant values for point bi-serial correlation. *Psychol. Repts.*, **4**, 607-8 (1958)
118. Perry, N. C., and Michael, W. B. A note concerning the reliability of a point

- biserial coefficient for large samples. *Educ. Psychol. Measurement*, **18**, 139-43 (1958)
119. Pickrel, E. W. Classification theory and techniques. *Educ. Psychol. Measurement*, **18**, 37-45 (1958)
120. Quandt, R. E. The estimation of the parameters of a linear regression system obeying two regimes. *J. Am. Statist. Assoc.*, **53**, 873-80 (1958)
121. Quenouille, M. H. *Fundamentals of Statistical Reasoning* (Hafner Publishing Co., Inc., New York, N. Y., 169 pp., 1958)
122. Ramachandran, K. V. A test of variances. *J. Am. Statist. Assoc.*, **53**, 741-47 (1958)
123. Ramachandran, K. V. On the Studentized smallest chi-square. *J. Am. Statist. Assoc.*, **53**, 868-72 (1958)
124. Reznikoff, M., and Toomey, L. C. The weighted Q sort: a procedure for quantitatively estimating emotional disturbance and personality change. *J. Consulting Psychol.*, **22**, 187-90 (1958)
125. Roberts, A. H. Chance frequency in matching problems when success or failure is reported after each matching operation. *J. Consulting Psychol.*, **22**, 233-34 (1958)
126. Roy, S. N., and Potthoff, R. F. Confidence bounds on vector analogues of the "Ratio of Means" and the "Ratio of Variances" for two correlated normal variates and some associated tests. *Ann. Math. Statist.*, **29**, 829-41 (1958)
127. Russell, T. S., and Bradley, R. A. One-way variances in a two-way classification. *Biometrika*, **45**, 111-29 (1958)
128. Ryan, T. A. Multiple comparisons in psychological research. *Psychol. Bull.*, **56**, 26-47 (1959)
129. Sagi, P. C. A statistical test for the significance of a coefficient of reproducibility. *Psychometrika*, **24**, 19-27 (1959)
130. Sawrey, W. L. A distinction between exact and approximate nonparametric methods. *Psychometrika*, **23**, 171-77 (1958)
131. Scheffé, H. Experiments with mixtures. *J. Roy. Statist. Soc., Ser. B*, **20**, 344-60 (1958)
132. Senders, V. L. *Measurement and Statistics* (Oxford University Press, New York, N. Y., 594 pp., 1958)
133. Silverstein, A. B. Nonparametric tests for the comparison of changes. *Psychol. Repts.*, **4**, 582 (1958)
134. Snedecor, G. W. Chi-squares of Bartlett, Mood, and Lancaster in a 2^3 contingency table. *Biometrics*, **14**, 560-62 (1958)
135. Sokal, R. R. Thurstone's analytical method for simple structure and a mass modification thereof. *Psychometrika*, **23**, 237-57 (1958)
136. Somerville, P. N. Tables for obtaining non-parametric tolerance limits. *Ann. Math. Statist.*, **29**, 599-601 (1958)
137. Srivastava, A. B. L. Effect of non-normality on the power function of t -test. *Biometrika*, **45**, 421-29 (1958)
138. Stephan, F. F., and McCarthy, P. J. *Sampling Opinions* (John Wiley & Sons, Inc., New York, N. Y., 451 pp., 1958)
139. Sterling, T. D. Publication decisions and their possible effects on inferences drawn from tests of significance—or vice versa. *J. Am. Statist. Assoc.*, **54**, 30-34 (1959)

140. Stevens, S. S. Problems and methods of psychophysics. *Psychol. Bull.*, **55**, 177-96 (1958)
141. Stewart, R. G. An IBM procedure for cumulative pattern analysis. *Educ. Psychol. Measurement*, **19**, 77-80 (1959)
142. Stuckert, R. P. A configurational approach to prediction. *Sociometry*, **21**, 225-37 (1958)
143. Sukhatme, B. V. A two-sample distribution-free test for comparing variances. *Biometrika*, **45**, 544-48 (1958)
144. Taylor, J. G. Scientific method in psychology: IV. *Brit. J. Statist. Psychol.*, **11**, 133-35 (1958)
145. Torgerson, W. S. *Theory and Methods of Scaling* (John Wiley & Sons, Inc., New York, N. Y., 460 pp., 1958)
146. Tryon, R. C. Cumulative communality cluster analysis. *Educ. Psychol. Measurement*, **18**, 3-35 (1958)
147. Tryon, R. C. General dimensions of individual differences: cluster analysis vs. multiple factor analysis. *Educ. Psychol. Measurement*, **18**, 477-95 (1958)
148. Tucker, L. R. An inter-battery method of factor analysis. *Psychometrika*, **23**, 111-36 (1958)
149. Tukey, J. W. A quick, compact, two-sample test to Duckworth's specifications. *Technometrics*, **1**, 31-48 (1959)
150. Tyler, F., and Michael, W. B. An empirical study of the comparability of factor structure when unities and communality estimates are used. *Educ. Psychol. Measurement*, **18**, 347-54 (1958)
151. Vandenberg, S. G. Some thoughts about possible changes in research practices resulting from the use of electronic computers. *Behavioral Sci.*, **4**, 163-64 (1959)
152. Wagner, H. M. Linear programming techniques for regression analysis. *J. Am. Statist. Assoc.*, **54**, 206-12 (1959)
153. Walker, H. M., and Lev, J. *Elementary Statistical Methods*, Revised ed. (Henry Holt & Co., Inc., New York, N. Y., 302 pp., 1958)
154. Wallace, D. L. Simplified beta-approximations to the Kruskal-Wallis H test. *J. Am. Statist. Assoc.*, **54**, 225-30 (1959)
155. Walsh, J. E. Comments on "The Simplest Signed-Rank Tests." *J. Am. Statist. Assoc.*, **54**, 213-24 (1959)
156. Watson, G. S. On chi-square goodness-of-fit tests for the continuous distribution. *J. Roy. Statist. Soc., Ser. B*, **20**, 44-61 (1958)
157. Welch, B. L. 'Student' and small sample theory. *J. Am. Statist. Assoc.*, **53**, 777-88 (1958)
158. Wesler, O. A classification problem involving multinomials. *Ann. Math. Statist.*, **30**, 128-33 (1959)
159. Wherry, R. J. Hierarchical factor solutions without rotation. *Psychometrika*, **24**, 45-51 (1959)
160. Wilkinson, G. N. Estimation of missing values for the analysis of incomplete data. *Biometrics*, **14**, 257-86 (1958)
161. Wilkinson, G. N. The analysis of variance and derivation of standard errors for incomplete data. *Biometrics*, **14**, 360-84 (1958)
162. Williams, E. J. Simultaneous regression equations in experimentation. *Biometrika*, **45**, 96-110 (1958)

163. Willingham, W. W., and Jones, M. B. On the identification of halo through analysis of variance. *Educ. Psychol. Measurement*, **18**, 403-7 (1958)
164. Willis, R. H. Lower bound formulas for the mean intercorrelation coefficient. *J. Am. Statist. Assoc.*, **54**, 275-80 (1959)
165. Wrigley, C. Objectivity in factor analysis. *Educ. Psychol. Measurement*, **18**, 463-75 (1958)
166. Wrigley, C., and Saunders, D. R. Application of the quartimax method of rotation to Thurstone's primary mental abilities study. *Psychometrika*, **23**, 151-70 (1958)
167. Zinger, A., and St.-Pierre, J. On the choice of the best amongst three normal populations with known variances. *Biometrika*, **45**, 436-46 (1958)

INDIVIDUAL DIFFERENCES¹

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Only as a highly imperfect mirror does the professional literature of a given year reflect what has been going on in a specialized area of psychology. The true story of what has transpired in the psychological study of individual differences between May, 1958, and May, 1959, is to be found, first of all, in the reports of thousands of persons tested in psychiatric hospitals, in child guidance and mental hygiene clinics, by school psychologists, by vocational counseling organizations, and by agencies handling the adoption of infants. Next, it is to be found in the records of hundreds of thousands of psychological tests and other evaluative devices administered to inductees and enlistees in the armed services, to candidates for admission to colleges, universities and professional schools, to men and women seeking positions in commerce and industry, and to candidates for selection or promotion under a merit system or civil service agency.

The story of the study of individual differences appears in hundreds and hundreds of carefully developed case histories of mental patients, and in detailed cumulative personnel records in business organizations. Somewhat disguised, it appears in the error terms of human engineering studies and of theoretical investigations in psychological laboratories. The parts of the story, however, appear in the professional literature only indirectly, that is, as the background of research studies that happen to be based on data collected in on-going, as opposed to experimental, situations. A fair proportion of the studies executed on individual differences never show up in the regular professional literature at all. Either they appear in the twilight zone of the multilithed and mimeographed research reports of the armed services and their contractors, or, for one reason or another, they remain in the investigator's files.

The year's story of the psychological study of individual differences is written also in the announcements of numerous openings for psychologists in clinics and hospitals, in government and industry, and in counseling and consulting organizations. Most English-speaking psychologists are now applied psychologists, and most applied psychologists deal primarily with individual differences. Judging from the demand for services of qualified psychologists, the diagnosis of individual differences, based on the psychological discoveries and inventions of the past half-century, is useful in numerous

¹ Abbreviations used in this chapter include: ACE for American Council on Education Psychological Examination; EEG for electroencephalogram; Mf for masculinity-femininity; MMPI for Minnesota Multiphasic Personality Inventory; P-F for Picture Frustration; PMA for Primary Mental Abilities; TAT for Thematic Apperception Test; WAIS for Wechsler Adult Intelligence Scale; WISC for Wechsler Intelligence Scale for Children; MAS for Manifest Anxiety Scale.

segments of our society. The professional worker in applied psychology often has published an article based on his doctoral dissertation, and occasionally he may submit a tidy article on a somewhat new test or a newly modified technique, but, like the practicing dentist or physician, he is generally too busy to make scientific discovery a major goal. Primarily he is concerned with the study of how particular individuals differ and not with the development of generalizable findings about individual differences.

It is against the background of continued, successful practice of psychology that we can attempt to evaluate the year's harvest of books and papers. For the most part we ignore professional discussions, elementary texts, and popular presentations. We seek contributions of immediate or eventual importance in understanding psychological differences between individuals, whether or not such knowledge is of immediate interest to practicing psychologists.

In the opinion of this reviewer there have been no major break-throughs comparable to triumphs of the past, such as, for example, the 1904 Binet Scale, the IQ concept of Stern, Woodworth's P-D Sheet, the Strong Vocational Interest Blank, the projective test, or, on the statistical side, the development of the concept of correlation by Galton and Pearson, or the correction for attenuation by Spearman, or the invention of test development methods and multiple factor analysis by psychologists on both sides of the Atlantic. However, the full implications of contemporary achievements are difficult to evaluate, and this reviewer may be wrong. He writes only of his May, 1959, perceptions.

A science develops in two rather different ways: by major and successful innovations of method and concept, and by minor discoveries and the refinement of older techniques and constructs. Of the master innovators of the first third of the century, when the theory and applications of the study of individual differences were largely developed, only Burt and Porteus have published in the field this year. The second generation of researchers have been energetic and competent. Their creativity, however, seems to have been expressed in the extension of psychological services, in the development of consulting and research organizations, and in making better measures of established traits rather than in new and fundamental discoveries. Perhaps widespread application and limited theoretical work are indicative of a fallow period, which will be followed by a new era of development as a third generation matures. It would seem that a half century is not enough time in which to exhaust the scientific possibilities of such an important topic.

METHODS OF INVESTIGATION

Factor analysis.—As for twenty-odd years, multiple factor analysis remains a method of choice in the search for behavioral dimensions along which individual differences exist. Shortcomings of factor analysis are commonly recognized, as in a symposium by Michael, Wrigley, Tryon & Guttman (121). Michael points out the need for greater objectivity in determining the num-

ber of common factors, for a consistent definition of simple structure, and for improved analytic means of rotating axes and of determining communalities. He also seeks better methods of matching factors from different studies. Wrigley asserts that we have little knowledge of how many factors to extract and points out the disagreements on tests of significance of the residuals, the disagreements in the methods of estimating communalities, and the status of graphical rotation as an art. He concludes that factor analysis fails to meet the criteria of a good statistical procedure but thinks that it can be made objective if the profession is willing to make the effort.

In the symposium and in a separate paper (169), Tryon urges simpler approaches on the factorists, while Guttman states that the evidence is now against a small number of common factors. In a discussion of the simplex (71) Guttman argues further for many factors. In the specific instance of the simplex, he asserts that its rank cannot be reduced, by modifying the main diagonal, to less than $n-2$, with n being the number of variables. Both algebra and psychology, he says, indicate that it is more proper to adopt large rank as the null hypothesis in connection with the communality problem rather than small rank, as accepted *a priori* by the followers of Thurstone. Cattell (23) takes a somewhat similar stand for more factors, declaring that, with some artificial exceptions, the number of factors to extract is always n and that a correlation matrix is likely to represent more than n common real factors and more than n common error factors. This anti-Spearmanism, so extreme that it is also anti-Thurstone, does not seem likely to gain general acceptance. Acceptance would mark the end of a search for a science of individual differences; what would remain would be the study of differences of individuals on specific measures and combinations of measures.

Continued mathematical interest in factor analysis is represented by Jowett's general exposition (86), by Maxwell's review of pertinent statistical techniques (113), and by Lawley's investigation of iterative methods of finding factor loadings when it is postulated in advance that certain specified loadings are zero (94). Lawley believes it is possible to outline methods of finding large sample standard errors of loadings and of the residual covariances.

The earlier hierarchical factor solution of Schmid & Leiman (148), regarded as a generalization of the multiple group and the Holzinger bifactor models, has been applied to data by Creager & Harding (31) and has been handled without rotation by Wherry (184). Another development in factor analysis is Tucker's interbattery method (170), which requires no communality estimates and provides information on the stability of factors over different selections of tests. A statistical test to judge the minimum number of factors involved is proposed.

The increasing availability of electronic computers has given impetus to the further development of analytic methods of rotation of the axes of projection after factor extraction. Kaiser (88) states that his varimax method defines mathematically the doctrine of simple structure and yields

invariant results under changes in the composition of the battery. Wrigley, Saunders & Neuhaus (190) find that the quartimax solution applied to Thurstone's primary mental abilities matrix yields a general factor and agrees closely with two of four prior analyses. Sokal (159) proposes a modification of Thurstone's analytical method for simple structure, while Fruchter & Novak (61) compare the analytical methods (which are more or less automatic) to direct rotation (which gives a better basis for determining the rank of the factor configuration) and the graphical method (which can be made to produce more near-zero loadings).

Bernyer (10) reconciles two different methods of factor analysis—Burt's and the Thurstone centroid—by showing that the factors ultimately obtained are very much the same. If the investigator obtains a simple structure of oblique factors, it can be transformed into a factor pattern containing both a general factor and group factors, as in the Burt model. Thus interpreted, Bernyer says, Thurstone's oblique structure actually tends to confirm Burt's theory of a hierarchical structure of the factors of the mind.

Scaling.—Two books on scaling, important for bringing together much that hitherto has been available only in scattered sources, have appeared during the year. Torgerson's *Theory and Methods of Scaling* (168) presents, integrates, and evaluates much basic material, while Thurstone's posthumous *The Measurement of Values* (167) presents in compact format his primary papers on scaling and the measurement of attitudes, in which his notable contributions slipped somewhat into the background of his own thinking as he became more and more engrossed in factor techniques. This welcome volume is a reminder of Thurstone's pioneering in the scientific study of values—work which, in the perspective of the decades, will, perhaps, be evaluated as at least as important as his development of multiple factor analysis.

In papers dealing with Guttman's scaling methods, Lord (106) notes that the principal components for the weighting system are the item scoring weights that maximize the generalized Kuder-Richardson reliability coefficient, while Heath (72) presents a machine method of computing Guttman's coefficient of reproducibility when the sample is large. Lesser (97), in applying Guttman scaling to TAT pictures, claims a coefficient of reproducibility of .91, but presents no data on either application of the scale to a new group or test-retest reliability.

A contextual effect in scaling is described by Fine & Haggard (51), who note that scale values of adjectives rated in the context of food increase significantly in the context of highly acceptable food and decrease in the context of unacceptable food.

Pattern analysis and configural scoring.—McQuitty (116, 117) and du Mas (40) are the year's most active proponents of taking patterns and configurations of information into account in order to increase the validity of tests or batteries. Of itself, the theory is perfect. Imperfections are appar-

ent only in practice, possibly because a profile is essentially a generalized difference score, with resultant increase of the proportion of error variance as compared with the same data utilized additively. McQuitty is more conservative in his evaluation of these procedures than is du Mas, who states that tests scored conventionally waste a very large amount of the available data and that, when configural analyses have been sufficiently well understood and developed, tests composed of from 5 to 20 items will very probably be superior as psychometric instruments to current tests of 500 or more items. However, neither the findings of Forehand & McQuitty (56) on predicting educational achievement from configurations of factor standings nor of du Mas & MacBride (41) on an application of "manifest structure analysis" to developing a short form of the Otis S-A are in any way impressive. Although Tyler (172) finds some stability of patterning of primary mental abilities from the fourth grade to the eighth (but not from the first to the fourth) and while Stuckert (164) and Muldoon & Ray (124) seem receptive to the use of patterns, triumphs of the method to date are nonexistent.

Reliability and sources of variance.—Cureton (32) proposes a new and rigorous concept of test reliability, namely, that it be reserved for cases in which all elements of unreliability have a chance to operate. He would admit as a reliability coefficient the correlation between alternate forms administered at times separated by the experimenter's best estimate of the optimum interval but would exclude commonly used methods of estimating reliability, such as test-retest, alternate forms not separated by an interval introducing new sources of error, split-half, and rational equivalence. Most test constructors will probably admit that Cureton's concept requires that all other reliability computations be regarded merely as operationally defined "estimates of reliability." Thus, while agreeing with Cureton, they will probably seek the more rigorous coefficient when feasible, but will continue to find less demanding procedures to be useful expedients.

Interest continues in response set both as a possible source of valid variance and as something to be corrected for or suppressed, as discussed by Broen & Wirt (16). Voas (177) thinks that by obtaining socially acceptable and self-descriptive answers contiguously on personality questionnaires he is able to reduce the bias in the self-descriptive answers. Asch (4) finds negative response bias to be associated with neurotic tendency and obsessive-compulsive trends. Nunnally & Husek (129) substituted randomly chosen foreign words for meaningful components of test items and found that responses demonstrated a predisposition of the subjects to give answers of particular kinds. An interesting incidental finding was a correlation of $-.69$ between amount of education and acceptance of causal statements. Metfessel & Sax (120) reported systematic biases in the keying of 42 per cent of the standardized tests they examined.

Whitcomb (185) identified answer-sheet marking as a source of variance,

reporting that intercorrelations and test-retest r s are higher when highly speeded tests use the same answer sheet. Gordon (68) found a significant difference in the scores of right- and left-handed subjects on a speeded perceptual test, but not on other types of material.

Test theory.—More rigor in convergent test validation is demanded by Campbell & Fiske (20), who suggest utilizing a matrix of intercorrelations among tests representing at least two traits, each measured by at least two methods. Measures of the same trait should correlate higher with one another than they do with measures of different traits involving different methods, and these correlations should be higher than the intercorrelations of different traits measured by the same method. If their clear and logical presentation proves to be influential, the effect on test development will be wholesome.

Lord (108) writes on the theory inferring the shape of the frequency distribution of true scores and on estimating the true score of each examinee. His paper (107) on the utilization of difference scores is more practical, since applied psychologists continue to feel the need for considering two measures simultaneously, one weighted positively, the other negatively, as in estimating change in a function.

Engelhart (47) discusses procedures for equating scores on two or more tests, while Lesser (98) points out population differences in construct validity. Gadel (63) finds a low but consistent relationship between curvilinearity of response distributions and decrease in item validity from original to cross-validation sample.

Measurement techniques.—The year brings a few innovations in or modifications of measurement techniques. One of the most interesting is described in a study by Strupp (163), who used a motion picture of a neurotic patient being interviewed by an inexperienced resident in psychiatry. There were 28 interruptions of 30 sec. each, during which the subjects (55 psychiatrists and 55 psychologists) were asked what they would have said. The enormous potentialities of the motion picture medium for psychological measurement have been recognized for years, as in the work of Gibson *et al.* (67), but few have attempted to master its intricacies.

Wölker (189) made an experimental comparison between four cards of the Murray TAT and four motion picture versions, similar in form and content. One of his film versions was posed by actors, the other three involved photographing the original cards at different distances and angles. He reports livelier reactions to the film version, in which the projective effect was increased and the narrative more aggressive and full of tension.

In a study of situational testing Tupes, Carp & Borg (171) set up a series of six role-playing military situations, each with two administrator-observers. The behavior score, with reliability of .40, had r s of .13 to .24 with criteria such as military proficiency and estimated officer effectiveness.

A tapping test, which contributes unique variance in the prediction of

the acquisition of skill in the use of keyboard machines such as the typewriter, has been developed by Flanagan, Fivars & Tuska (54). Two sections involve the ability to tap with one finger at a time by controlling each finger separately, and the remaining seven sections of progressive difficulty involve learning to respond with a particular finger on perceiving a symbol. Reliability on separately timed halves is of the order of .90, and validities in predicting typing success range to .60. The correlation with intelligence is negligible.

Bass' Famous Sayings Test (6) purports to be an objectively scored personality test lacking structure for the examinee. The only scale considered long enough for individual diagnosis is that of social acquiescence. There is some evidence that salesmen tend to be high in conventional mores and fear of failure and to be low in hostility.

Another innovation is the North Central Test of Mental Ability developed by French (60) especially for use with physically handicapped children. While it requires near-normal hearing and vision, neither verbal nor manipulative responses are involved. Reliability coefficients of .97 are reported, together with a high correlation (.89) with age. Other innovations in test construction are Webster's (182) use of a factorial experimental model to construct an improved forced-choice test; Holland's (76) Personality Inventory using 300 occupational titles as content; Weingarten's (183) Picture Interest Inventory; and Pascal & Jenkins' (134) experiment with a concept formation test involving delayed reaction and alternation. This measures an ability not tapped by usual intelligence tests, and it may be related to the efficiency of the frontal association areas.

New tests.—New tests reported in the aptitude area include the Modern Language Aptitude Test by Carroll & Sapon (21), Jastak's Test of Potential Ability and Behavior Stability (85) and a test of mechanical comprehension by Lienert (102).

In the inventory area, Sen & Kundu (153) describe the development of a new introversion-extraversion measure in India which employs "non-aggressive and slightly projective" items but includes 15 "aggressive" items. Cattell, Beloff & Coan (25) in the IPAT High School Personality Questionnaire have carried the well-known 16 Personality Factor Questionnaire down to the 12-year level. Liverant (105) used Rotter's social learning theory in developing an inventory which seems to measure need for recognition in academic and social situations and the need for love and affection in social situations. Berdie & Layton (9) have published a new counseling inventory.

Two interest inventories in specialized professional areas have been developed: Symonds' Educational Interest Inventory (165) and Bendig's Psychological Activities Interest Record (8).

Among the personality tests, Zaks & Walters (192, 180) have developed an aggression scale, for which they present some evidence of validity. An

interesting development is that of Peters (135), who has devised a word association test in multiple choice form. Within groups of subjects of homogeneous educational level he finds a positive relationship between maladjustment and the tendency to choose the superordinate association.

In the projective area, an experimental test is Petrovich's Pain Apperception Test (137) of 25 pictures, which has a positive relationship with Eysenck's medical questionnaire and with the Taylor MAS. Another is Kerman's projective test to use with the blind (90), consisting of rubber replicas of six cypress knees, selected to yield psychodiagnostic and psychodynamic material. It is not yet validated.

Dole (36) suggests a vocational sentence completion blank for use in counseling, and Stone (162) another modification of the Rorschach. The IES test by Dombrose & Slobin (37) is designed to measure the relative strengths of id impulses, the ego and the superego; while Williams' test (187) with the code phrase PEN PALS ("Projected Essential Needs, Parental Authority-Love Statements") purports to be a technique for children to evaluate both parents. Cassel & Kahn (22) report that their Group Personality Projective Test, third edition, consisting of stick-figure drawings to be interpreted by the multiple-choice technique, differentiates between "typical subjects" on the one hand and federal prisoners and neuropsychiatric patients on the other.

Mosak (123) suggests the use of early recollections as a projective technique, while Newstrand (127) recommends that the subject be asked what he would most like to hear said about himself.

As yet, psychologists have not learned to predict with accuracy the acceptance of new techniques and tests. Accordingly, it is hard to say which of the innovations will remain under investigation or be in use a decade or two hence. The felt needs of the profession, the success of the device in meeting the felt needs, and more or less blind chance are all involved.

The greatest achievements of psychological measurement have been reached when the behavior of interest has been actually evoked in the testing situation. Thus, behavior susceptible to measurement in relatively short periods of time with the subjects motivated to do their best can be used to predict similar behavior in the future. This we might call "Type I" psychological measurement, covering intelligence (or symbolic aptitude), specific aptitudes, and achievement or proficiency measures.

Another type of measurement depends on the co-operation and veracity of the subject in reporting his past behavior over long periods of time and his present likes and feelings. When his reports can theoretically be verified, as in a biographical data blank, they seem to have considerable utility. In counseling and clinical situations, where the subject is motivated to co-operate, the self-report device has also proved useful.

The third category of appraisal devices, in which the behavior of interest is neither evoked by the situation nor reported by the subject, involves the greatest difficulties. Most of the projective techniques fall in this category.

In the "personality" area of human behavior, trait names abound and the behaviors covered extend over long periods of time, involve many individuals other than the subject, and often cannot be accurately reported by the individual exhibiting the behavior.

In predicting the future of new psychological devices, we can be reasonably confident that Type I tests that provide a new type of important information will be used until replaced by something better. Interest tests and personality questionnaires are more difficult to appraise. Those which have gained acceptance typically attempt to assess a wider spectrum of characteristics than do aptitude or proficiency measures, and it is harder to find unoccupied territory, except perhaps by building tests for special categories of subjects.

The third category remains, as for years past, a chaotic realm where dependable knowledge is difficult to obtain. The Rorschach, the TAT, and probably some other projective instruments are undoubtedly excellent conversation pieces. Confronted with them, patients will talk and, in expressing themselves, reveal themselves. Apparently the capable and experienced clinician is thereby enabled to make a plausible and often useful assessment. Whether any of the newer projective devices will go beyond this stage and yield verifiable information about types or traits, it is impossible to say. Perhaps what personality measurement most needs is job description of the criteria the tests are supposed to predict.

MEASUREMENT PROBLEMS AND FINDINGS

Intelligence and other abilities.—Burke (18) has reviewed the work on Raven's Progressive Matrices, a nonverbal test which has been mentioned as a possible pure measure of Spearman's "g." Somewhat similarly, Sehringer (150) has reviewed the work on the Goodenough test. Porteus (143) presents an excellent summary of his position on the maze tests, while Burt (19) states his belief that it is possible to estimate the relative contributions of environmental and genetic conditions to intelligence.

Semeonoff & Trist (152) have published a manual covering five basic apparatus tests for measuring intelligence, some newly developed, others modified from prior tests and based upon wartime experience in the selection of officers. The first part of the manual for the 1948 revision of the Leiter International Performance Scale has now been published (96), and Sharp (154) found a test-retest reliability of .91 for 48 retarded children tested at an interval of six months.

Studying the stability of intelligence measures, Bradway, Thompson & Cravens (14) retested 111 of 212 individuals in the standardization group of the 1937 Revision of the Stanford Binet. The test-retest correlation was .59, with a mean IQ some seven points higher. Nisbet & Buchan (128) found that while accurate prediction of scholastic attainment in the university is not possible from tests administered to 11-year-old children, r s are positive, ranging from .05 to .28.

Watts (181) conducted a long-term study of the effects of age and practice on the intelligence performance of grammar-school girls and found improvement through seven testings; he ascribed the improvement more to the effects of practice than to the effects of age.

Reviewing studies from several sources, Conway (30) concludes that the influence of genetic factors greatly outweighs that of the environment in determining intelligence, but that the differences in the averages for the social classes are influenced by a constant diffusion of persons who pass from class to class.

Pettigrew (138) developed a test of judgment of category width, in which subjects are required to judge ranges phenomena, such as the annual rainfall in Washington, D. C., and the length of whales. Scores correlated .26 with the Q-score of the ACE but were not related to measures of dogmatism. Honkavaara (77) finds that the principle of similarity in grouping similar objects is related to mental development. Levine *et al.* (99) assert that the "delay function of the ego" bears some relationship to general intelligence. Studying 34 accumulated records for which both Wechsler IQs and EEG measures were available, Mundy-Castle (125) found a correlation of .51 between total IQ and mean alpha frequency, but the correlations of test scores and alpha index were inconsistent.

In investigating the mental growth curve defined on an absolute scale, Indow (81) was unable to confirm Thurstone's finding that variability in intelligence can be extrapolated to zero about three months before birth.

Reviewing studies in various colleges and universities, Plant & Richardson (141) found the average Wechsler IQ of college freshmen to be 116, with 120 as the average of all college students. Plant & Lynd (142) reported the full-scale Wechsler to be more valid for predicting grade point average than the ACE, .52 and .35 being the respective validities. With both tests, validities of the verbal score alone are somewhat higher. Levinson (100) finds that on the Stanford-Binet the vocabulary test overestimates the mental age for native-born children and underestimates it for foreign-born children. Schultz (149) obtains simple structure of four oblique factors for the Holzinger-Crowder Uni-Factor Tests, while Lotsof *et al.* (109), factoring the WISC and the Rorschach, find four main factors of verbal intelligence, productivity, perceptual movement, and performance speed. One of their conclusions is that the Rorschach should not be used to assess intelligence.

Witryol & Kaess (188) demonstrated the existence of reliable individual differences in the perception of synthetic speech, and noted that voicing errors and placing errors may be independent. In a factorial study of the memory area, Christal (27) found that memory for color is relatively independent of associative memory but that incidental and purposive memory require the same ability. Special abilities seem to be required for remembering positions of objects in space and the relative positions of events in a time series.

In appraising long-published tests, Ennis (48) concludes that the Watson-Glaser Tests of Critical Thinking give too high a score to the chronic or pathological doubter. Rusmore (145) found the Cardall Test of Practical Judgment to have a reliability of .45 and a validity of $-.03$ for service order dispatchers, with a criterion reliability of .74. Rusmore questions the desirability of continued use of the test.

Interests.—Smith (156, 157) extracted ability and preference factors from a test battery and thus found his factors related not only to academic success but also to choice of study program. From a study of the specialization of interests and academic achievement, Edwards & Wilson (43) concluded that when universities and colleges select students on the basis of academic grades, they place students who have theoretic interests at a disadvantage, and that underevaluation of the theoretic student means underevaluation of those with the abilities needed to do creative work in the natural and social sciences.

Dupont (42), using interest as a measure of group adjustment, concluded that people who fit into the group adapt more easily to their work than those who do not.

A study of Pierce-Jones (140) established that it is possible to derive a measure of socioeconomic status through interest-inventory responses and that such a measure has a definite relationship with objective socioeconomic status. Voas (178) found no relationship of Kuder Preference Record scores to success in flight training, when mechanical ability is controlled. In another study involving the Kuder, Hill & Hole (74) found that 80 per cent of parents correctly identified two or three of the top three interests of tenth-grade students. Bender (7) ascertained that in the 15 years since college the religious interests of 112 men increased by nearly a standard deviation, with the measure correlating .79 with church attendance. However, he ascribed the change more to the temper of the times rather than to increasing maturity, since present seniors now have higher religious interests than did seniors in 1940.

Projective methods.—In a systematic consideration of projective techniques (103), Lindzey concluded that classification based upon the mode of response elicited from the subject was the most promising. His five categories, with an example of each, are: association (Rorschach), construction (TAT), completion (Rosenzweig P-F), choice or ordering (Szondi), and expression (psychodrama). Other possible classifications considered but discarded were: stimulus attributes, manner of interpretation, purpose, method of administration, and method of construction.

Vernier, Stafford & Krugman (175) factored 35 variables from four projective devices and related the resultant seven factors to physical disease. Such pathologies as respiration, cardiac, and neurological illnesses had loadings on some factors, but personality factors and specific types of physical disease were generally independent of each other.

Okarski (130) found that movement responses were not predictable from one projective device to another and therefore questioned the validity of certain basic assumptions underlying the projective techniques. Fisher (53) reports that the embarrassment and anxiety induced in 50 hospitalized women by a disturbing physical examination had no effect on their responses on several projective instruments. Davids & Pildner (34) found that personality assessment measures are likely to be distorted when there is strong motivation to make a favorable impression.

Personality.—Cattell is certainly one of the most prolific workers in the investigation of the phenomena of personality and motivation. Two important reviews of his work have been published—one by Sells (151) and one by Eysenck (49). Both express admiration for the scope of Cattell's attempt to develop an objective science of personality as a foundation for clinical psychology but are cautious in accepting the whole fabric of his findings, especially the large number of factors.

Jackson & Messick (84) find that stylistic determinants, such as acquiescence, overgeneralization, and tendency to respond in socially desirable or undesirable ways, account for a large proportion of the variance on some personality scales, such as the MMPI and the California F-Scale. They feel that research involving response style may contribute to a more systematic measurement in personality and may pay off handsomely in helping to further the common ground between personality theory and personality measurement.

Stanek (160) found low intercorrelations (.17 to .23) among three measures of masculinity-femininity, a graphic rating scale, Form A of the Terman-Miles Attitude Interest Test, and the *Mf* scale of the MMPI. The appropriate conclusion is that the common factor is not very large. In a somewhat similar study, Fiedler *et al.* (50) intercorrelated various suggested measures of adjustment and decided that adjustment "is not a unitary trait in an unselected population."

Cattell & Baggeley (24) report finding eight simple-structure factor patterns in personality tests which possess great resemblance in content to the drives hypothesized in man and the primates by Darwin, Freud, McDougall, and Murray. These are sex, self-assertion, protectiveness, fear, narcissism, gregariousness, rest-seeking, and curiosity. In addition, they identify five learned patterns, including religious sentiment, interest in sports and games, and interest in the mechanical-materialistic area.

Fulkerson (62) reports consistently lower validities for personality tests within groups at the hysteric end of the personality dimension. Differences in carefulness of responding, as measured by the McKinney Reporting Test, seemed to be an important variable in determining this relationship.

Merenda & Clarke (118, 119) believe that human behavior can be usefully described in terms of aggressiveness, sociability, emotional stability, and social adaptability and that these characteristics can be assessed when the subject checks words that have been applied to him and words which do

apply to him out of a total list of 81 nonderogatory words. They find the reliability of the profiles, used in classifying male industrial employees, to be from .72 to .77.

Binder (13) finds that high paranoid scores are associated with the tendency to withhold perceptual responses until a relatively low amount of uncertainty is present. Yeslin, Vernon & Kerr (191) discovered that individuals with misgivings and anxieties about their prospects in sales work tend to spend more time in answering questions relating to sales personality and sales interest than on questions not directly related to sales. Chown (26) found personality factors influencing occupational choice, preference for office work being related to low confidence in girls and to high sociability in boys. Smith & Marke (158) report that the Humm-Wadsworth Temperament Scale is sensitive to changes in the testing situation and that when the test is taken as if it were being used for selection, there is an increase in scores in the normal component and decrease in the pathological component.

Davids & Parenti (33) present evidence that popular children, as determined by sociometric choices, tend to be well-adjusted emotionally and to possess socially desirable personality traits. Liddle (101) finds that intellectual talent, social leadership, and artistic talent are positively related and that children exhibiting these characteristics are not likely to be withdrawn. People with emotional problems are more likely to have dental caries, according to a study by Manhold & Hafner (112). Dorfman (39) reports that reliable improvements occur on the Rogers Test of Personality Adjustment and on a sentence completion personality test concurrently with a series of therapy sessions. Schaie (147) reports interaction between rigidity-flexibility as measured by the Schaie Test of Behavioral Rigidity and Thurstone's Primary Mental Abilities at every age level, the flexible being the more intelligent.

In investigating expressive graphic movements and their relationship to temperament factors, Talmadge (166) found individuals to be consistent in a number of variables, such as personal tempo, amount of pressure applied, and length of graphic reproduction, but that relationship with temperament measure could not be regarded as demonstrated. Peterson, Quay & Anderson (136) matched delinquents and nondelinquents for race, age, and place of residence and then compared the two groups on the socialized scale of the California Psychological Inventory. Some 70 per cent of both groups were correctly identified, and "good citizens" in high school were differentiated from "disciplinary problems," thus extending the construct validity of the scale. A multiple correlation of .40 was found by Izard (83) between a self-descriptive inventory, physical aptitude, scholastic aptitude, and mechanical aptitude on the one hand and sociometric measures of leadership on the other.

Comments on approximately 40 additional references on individual differences in personality (some of which are just as noteworthy as those actually mentioned) might have been included in this chapter, but were omitted

because of lack of space. It is believed, however, that the studies mentioned are reasonably representative of the year's trends. Few of the findings would be very surprising to anyone who has followed the literature on personality differences for the past decade or two; yet, taken together, the papers represent a continued accretion of knowledge in this area. Personality measurement devices are neither as good as one would like nor as bad as one might fear. The over-all conceptual framework is foggy and varies greatly from investigator to investigator. The effort expended in this area of investigation has been prodigious and is increasing. However, the field probably needs less ant-like industry and more beaver-like direction.

Studies of specific personality instruments.—The original plan for this chapter called for consideration of research centered in specific personality instruments. The literature was scanned and 136 publications abstracted after examination, enough perhaps for a separate chapter of the *Annual Review*. Space limitations preclude even the listing of the titles.

Categories in the following distribution are reasonably discrete. However, when two or more instruments were compared in the same article, the device appearing first in the title, or obviously emphasized in the text, became the basis of classification.

The most popular was the MMPI with 34 titles; followed by the Taylor MAS with 20 titles (including 3 on the children's MAS); and the Rorschach with 19. The test anxiety scale and the TAT had 9 each, while the Bender Gestalt and the California F-Scale were represented by 8 publications each. There were 6 articles on each of the following: the Edwards Personal Preference Schedule (EPPS); the need Achievement measures of McClelland (n-Ach); and human figure drawing as a projective technique. The sentence completion method was represented by 5 titles, while the 16 Personality Factor Test and the Szondi have 3 each. Two of the articles on the Szondi were in German.

The topics (or should we say *themas*?) of the articles centered in the correlates, reliability, and unity of obtained measures; the breaking-up of overall measure into components; the influence of experimental conditions and the determinants of responses; the use of the devices in clinical practices and as predictors of academic and occupational criteria; applications to specific groups of subjects, as age, sex and diagnostic groups; and modified forms and possible new measures to replace existing instruments.

A special undertaking in this area was a series of studies made by Comrey [e.g., (29)], each examining the factorial composition of a single MMPI scale. A uniform design was followed and the data seem to have come from the same group of Ss. From the intercorrelations of age, sex, hospitalization, and the items of a scale, centroid factors were extracted and rotated on a computer by the Kaiser varimax method. In general, the number of factors found and interpreted was about one-third of the number of items, which would not appear to be sufficiently conservative. Comrey's over-all conclu-

sion that empirically derived scales are not internally homogeneous is not surprising. The development of homogeneous keys for the MMPI, each with a minimum of overlap with other keys, would be an enterprise more worthy of extensive computational effort than a monotonous series of factor analyses of existing keys.

GROUP DIFFERENCES

The aged.—Since another chapter of the *Annual Review* is concerned with Gerontology, we mention only a few titles of special interest from the point of view of individual differences.

Freeman (58, 59) has developed a pre-retirant test yielding 7 interest scores, 5 value scores, and 5 personality scores. He reports reliabilities of .48 to .87, and correlations of from .56 to .87 with interview data. After applying the test in various hobby groups, he finds that the pre-retirant with broad educational background and many interests is more likely to find a healthful avocational retirement pattern than the less well-educated pre-retirant.

In a study of WAIS performance on an aged sample, Eisdorfer, Busse & Cohen (44) found consistent superiority of verbal IQ over performance IQ.

Hirt (75) using the General Aptitude Test Battery to determine aptitude changes with age, found the usual curvilinear relationships with age and the following peaks of performance: general intelligence, age 37; verbal ability, 31; numerical, 32; and spatial, 30. On the personality side, Orme (133), using the Rorschach, found some restriction and egocentricity in normal old people and more severe restriction in elderly depressives and in senile dementia.

Mental patients.—The critical incident approach, developed by Flanagan as a basis for evaluation in industrial situations, has been extended by Flanagan & Schmid (55) to the study of psychopathology. Two exploratory studies were sufficiently encouraging so that further development is contemplated.

Guertin & Krugman (70) rated a group of patients on 191 items and factored the intercorrelations. Six major factors emerged to form the basis of their scale for rating the activities of psychiatric patients: deteriorated behavior, interpersonal tension, emotional controls, resistive isolation, regressive agitation, and reality concern. In the same general area of research, Stilson *et al.* (161) compared two behavior rating scales for mental patients, the Hospital Adjustment Scale with a test-retest reliability of .79, and the Multidimensional Rating Scale for Psychiatric Patients, for which .80 was found to be the reliability. Scores on the two scales correlate .57, yielding a correlation corrected for attenuation of .72. Briggs (15) structured the psychiatric case history by developing homogeneous keys based on 175 items of information collected from informants. Eight item clusters were investigated, of which one (poor social relations) was dropped. The seven clusters retained relate to achievement, psychopathy, schizoid tendency, neuroticism, conflict with parents, hypochondriasis, and unstable home. Bryant *et al.* (17)

factored 28 items of a behavior rating scale applied to hospitalized mental patients, simplifying it to the following main traits: integration-adaptation, organic condition, psychiatric content, rage, and social interaction. Ellsworth & Clayton (46) find that measures of behavioral adjustment, derived from the MACC Behavioral Adjustment Scale, and psychopathology are significantly related. The four traits involved are motility, affect, co-operation, and communication. Behavioral adjustment on discharge is also related to the level of community adjustment three months later.

Pichot (139) has reviewed methods for the use of mental tests in psychopathology. Reitan (144) finds that a trail making test, involving connecting 25 circles in numerical sequence as fast as possible, and also an alternative task, definitely differentiates between organic brain-damaged patients and patients without brain pathology. If the recommended cut-off is used, there would be false diagnoses in about 15 per cent of the cases.

On the basis of a factor analytic study of cartoon humor among 106 psychiatric patients, Abelson & Levine (1) decided that the themes liked, such as interpersonal hostility and voyeurism-exhibitionism, permit the indulgence of inhibited impulses; while the themes disliked, such as uncivilized or hostile behavior, and victimization or trickery, arise from superego prohibitions and are psychologically forbidden activities.

In a study of paranoid schizophrenic and normal subjects' perceptions of human faces, Izard (82) had two groups of subjects rate 16 photographs of normal human adults. Schizophrenics expressed more unfavorable feeling; perceived others as tense, suspicious, hostile, and threatening; and had sudden shifts of attitudes and behavior. In general, they were characterized by highly variable perception and behavior.

Mental retardation.—Another field characterized by good research during the year is mental retardation. Sarason & Gladwin (146), Masland (110), and Molish (122) have published important reviews of research; and there have been books by Masland, Sarason & Gladwin (111) and by Kirk (91).

An abbreviated WISC, consisting of the subtests of information, picture arrangement, picture completion, coding, and block design for use with the educable mentally retarded has been suggested by Finley & Thompson (52). It yields a multiple correlation of .90 with the full scale, with a standard error of measurement of 3.1 IQ points.

Using a sample of mental defectives, Alper (2) correlated the Arthur adaptation of the Leiter International Performance Scale with the WISC. He found the correlations to be .40 with the verbal WISC scale; .79 with the performance scale; and .77 with the full scale.

For 182 mentally retarded children, the test-retest correlation of the 1937 Stanford-Binet IQ was found by Collmann & Newlyn (28) to be .93. They found no association between very adverse home conditions prior to transfer to a residential school and subsequent change in IQ.

Kralovich (93) matched groups of organic and mongoloid subjects and

found significant differences between them in motor performance. Differences were most significant between five and ten months of mental age.

In a study of high-grade hospitalized mentally retarded children, Gibson, Jephcott & Wilkins (66) found that performance in certain school subjects, namely, arithmetic, grammar, and composition, varies with the cause of the mental deficiency. In another study in which the reasons are not yet apparent, Ellis & Sloan (45) found that defectives characteristically have higher skin conductance than normals but that within a group of 125 mental defectives variation in skin conductance was not related to IQ.

Badt (5) studied the levels of abstraction in vocabulary definitions of mentally retarded school children and concluded that institutionalization has a strong depressing effect upon the subjects' ability to define words abstractly, as indicated by a correlation of $-.61$ between length of institutionalization and abstraction score. The correlation remains highly negative even when mental age and chronological age are controlled. The longer he is in an institution, Badt says, the less a mental retardate is able to think abstractly and to manipulate concepts.

Lipman (104) studied two groups of retardates differing markedly in overt aggression, but who were matched for age, sex, race, IQ, and sociocultural background. He applied certain personality measures to the two groups and found that direction of aggression or trends on the Rosenzweig P-F had little or no relationship to behavioral aggression. Similarly the Children's Manifest Anxiety Scale had no relationship to overt aggression, but a mirror-drawing task did differentiate the groups.

Standardized intelligence tests are positively correlated with most motor performance tests, according to a finding of Francis & Rarick (57), who found mentally retarded children markedly inferior to normal children in all motor performance tasks. With age, the differences become greater. Distefano, Ellis & Sloan (35) also found evidence of a positive relationship between mental age and motor proficiency.

In comparing the performance of brain-injured and familial mentally deficient children on visual and auditory sequences, Hunt & Patterson (80) used groups matched on IQ, chronological age, sex, and training. On visual, auditory, and combined sequences, the familial mentally deficient performed better.

The effect of a program of physical conditioning exercises and activities on the mental characteristics of educationally subnormal boys was investigated by Oliver (131). Using the control group technique, he found that 10 weeks of systematic and progressive physical conditioning improved the physical qualities and abilities of boys with IQs averaging 70. Some improvement in intelligence test scores was noted, as well as apparent better emotional adjustment.

Using 37 imbeciles as subjects, House & Zeaman (78) studied discrimination training, with candy as reinforcement. The technique was similar to

that used by Harlow with naïve monkeys. When a criterion of 20 of 25 trials correct was used, 17 of the 37 imbeciles learned the discrimination in 10 days. In similar circumstances, all 12 of Harlow's monkeys learned the task in two days.

Lederman (95) has investigated small-group observations as a diagnostic technique with patients in an installation for the mentally retarded. Four patients meet with an observer for six sessions. Observing small-group interaction shows promise as a diagnostic and prognostic technique, especially in the evaluation of community placement possibilities. It is also more economical than the usual projective test battery and individual interviews and conferences with staff members.

In a study of 120 children, of whom half were boys and half were girls, and of whom one-third were of low IQ, one-third average, and one-third of high intelligence, Klausmeier & Check (92) found positive relationships between IQ and height, strength of grip, reading, arithmetic, and language. On the other hand, no significant relationship was found between intelligence and emotional adjustment or expression, or tendency to be withdrawn or aggressive, or the child's estimate of his own learning ability.

Delinquency.—A statistically significant difference between performance and verbal IQs was found by Wiens, Matarazzo & Gaver (186) in a group of 112 sociopaths with records of a court conviction of sexual crime. The mean performance IQ was 104.0 compared with a mean verbal IQ of 97.6. Graham & Kamano (69) report that the criminal "unsuccessful reader" tends to show a psychogram on the WAIS typical of the youthful psychopath, while the "successful reader" does not. Doppelt & Seashore (38) find that with prisoners between the ages of 16 and 24, the verbal and abstract reasoning tests of the Differential Aptitude Tests yield a correlation of .82 with the WAIS while with prisoners from 25 to 35, the verbal and numerical portions of Personnel Tests in Industry give a correlation of .85 against the same criterion. Gibbens (65) found the Q-score on the Porteus maze to be related to the manic scale on the MMPI in a group of 200 delinquents, ages 16 to 21. The Q-score is an error score which correlates negatively with intelligence.

Kahn (87) compared murderers and burglars and found murderers to have more rigidity and poorer control, as assessed by the Rorschach, and poorer abstract ability as measured by the Wechsler.

Race differences.—Newman (126) studied early adolescent and late adolescent children of the Otomi Indian group in Mexico. On the Rorschach there was little change from the period between 12 and 15 years to the period between 17 and 20 years, with few indications of "storm and stress."

Comparing Navaho Indians with Wechsler's norms on the WAIS, Howell, Evans & Downing (79) found the Navahos lower on the verbal, performance, and full scales, with greater difference with the white norms on the verbal scale than on the performance scale. In the subtests, the Navahos were slightly better than the standardization group on block design and

object assembly. The authors do not regard their findings as indicating innate differences, since they state "valid comparisons of intellectual ability can be made only within a culture and not between cultures."

On the Primary Mental Abilities Tests Walters (179) found Maoris relatively strong in numerical ability and word fluency and relatively weak on the tests of verbal meaning, space, and reasoning. The Maoris did less well on a totally nonverbal test (compared with a control group of white New Zealand children) than on PMA. Maoris from the country (from schools with programs designed to meet their needs) did better on the tests than the city Maoris. Walters states that nonverbal tests may not be efficacious in the assessment of culturally-handicapped groups. Verhaegen & Laroche (174) came to a somewhat similar conclusion in their discussion of testing African natives. They state that tests such as the Progressive Matrices and Cattell's Culture-Free test have little significance for people without contact with European culture.

The matter is also considered by Biesheuvel (12) who came to the conclusion that no scientific answer can be given to questions concerning the genetic components in the behavioral differences between races. He states that "it will not be useful to include at this stage the formulation of such questions in African research programs." He believes, however, that a broad program of psychological research in Africa is socially valuable, providing a means whereby African potentialities can be more fully realized and whereby group differences in well-being can be reduced.

On the question of methodology in the study of attitudes of Africans, Biesheuvel (11) points out that problems of rapport and validity require particular attention, since there is difficulty in ensuring that verbalized attitudes reflect actual beliefs, ideas, and feelings. He reports the development of a "conversations" attitude inventory consisting of 40 imaginary conversations among Africans discussing how they should behave. The respondent has to choose the "wisest reason" in discussions in areas such as ethico-legal matters, religion, expediency, and tribal tradition. Biesheuvel reports good reliabilities for the device.

Geber (64), in studying the psychomotor development of African children in their first year, had to modify the Gesell tests somewhat, because tester, child, and mother all sat on the ground. Compared with white standards, there was an all-around advance of development, which was greater the younger the child. One possible explanation is that before a child is weaned, the whole interest of the mother is centered upon it.

Ombredane, Bertelson & Beniest-Noirot (132), in discussing differences between African and Belgian children on a paper-and-pencil percept test, said that their finding was more easily explained by a general lack of interest in speed performance than by a slower operation of mental functions.

After finding the IQs of Negroes on the Colored Raven Progressive Matrices to be significantly lower than their Stanford-Binet IQs, Higgins &

Sivers (73) came to the conclusion that nonverbal intelligence items may actually discriminate against the Negro.

There has been a revival of discussion of the question of Negro-white differences in intellectual abilities with the publication of Shuey's *The Testing of Negro Intelligence* (155) and a paper by McCord & Demerath (114), with rejoinder by McGurk (115).

McCord & Demerath attacked an earlier presentation by McGurk in a popular magazine on race differences, a presentation which McCord & Demerath interpreted as biased in favor of white superiority. In refutation they cited a study in which, with environmental influences controlled, differences in intelligence test scores between Negroes and whites failed to appear. In his answer, McGurk stated that the:

social and economic manipulations of the past 35 years have not changed the psychological test score relationship between Negroes and whites. Until such a change is demonstrated empirically, the opinions of authorities that changes have occurred, or will occur, are meaningless.

Shuey, in careful, methodical fashion, surveys 240 studies, of which 238 are from the United States, of differences between whites and Negroes on standard psychometric tests. She points out that even when social and cultural factors are considered Negroes produce proportionally only one-sixth to one-third as many gifted as whites, but six times as many retarded.

Of course, the basic issue is methodology. The psychological literature of the twenties and thirties is littered with race difference studies that revealed undoubted cultural differences between Negroes and whites, but in which the design was totally inadequate to investigate genetic factors. Nevertheless, from the repeated findings of differences at the descriptive level, some readers of the reports have tended to infer underlying genetic differences. The times would seem to require: (a) a few more articles like Biesheuvel's on methodological considerations; and (b) studies appropriately designed to yield information on possible inherited differences in mental ability. The second requirement is far more difficult than the first.

In the study of personality, the picture is scientifically brighter with the publication of Karon's *The Negro Personality* (89). Carefully planned and executed, Karon's study sets the stage for better understanding of race in America.

CONCLUSION

An appropriate way to conclude this review of current scientific study of individual differences might be to refer readers to new publications covering a comprehensive view of the field, a discussion of certain applications, and a theoretical orientation.

The third edition of Anastasi's *Differential Psychology* (3) meets the first requirement magnificently. Vernon (176) discusses the uses of measurement in encouraging the fullest development of the varied mental capacities and

inclinations of students, while Tyler (173) calls for the extension of our present conceptual framework. She finds that the basic concept of an individual as a point in n -dimensional space is not sufficiently fruitful. Factor analysis, she says, is no longer a simplification, and multiple R s are not increasing. "Individuality will continue to elude us as long as we restrict ourselves to models based on dimensions or trait continua." As a specific contribution, she offers the study of pattern of choices as leading to a workable psychology of individuality.

New leads, such as Tyler's, are essential to the continued growth of a field such as this. The best prediction about the field is that it will continue to grow.

LITERATURE CITED

1. Abelson, R. P., and Levine, J. A factor analytic study of cartoon humor among psychiatric patients. *J. Personality*, **26**, 451-66 (1958)
2. Alper, A. E. A comparison of the Wechsler Intelligence Scale for Children and the Arthur adaptation of the Leiter International Performance Scale with mental defectives. *Am. J. Mental Deficiency*, **63**, 312-16 (1958)
3. Anastasi, A. *Differential Psychology*, Third Ed. (The Macmillan Co., New York, N. Y., 664 pp., 1958)
4. Asch, M. J. Negative response bias and personality adjustment. *J. Counseling Psychol.*, **5**, 206-10 (1958)
5. Badt, M. I. Levels of abstraction in vocabulary definitions of mentally retarded school children. *Am. J. Mental Deficiency*, **63**, 241-46 (1958)
6. Bass, B. M. Famous Sayings Test: general manual. *Psychol. Repts.*, **4**, 479-97 (1958)
7. Bender, I. E. Changes in religious interest: a retest after 15 years. *J. Abnormal Social Psychol.*, **57**, 41-46 (1958)
8. Bendig, A. W. Development of the psychological activities interest record. *Educ. Psychol. Measurement*, **18**, 159-66 (1958)
9. Berdie, R. F., and Layton, W. L. *Minnesota Counseling Inventory* (The Psychological Corporation, New York, N. Y., 1957)
10. Bernyer, G. Second order factors and the organization of cognitive functions. *Brit. J. Statist. Psychol.*, **11**, 19-29 (1958)
11. Biesheuvel, S. Methodology in the study of attitudes of Africans. *J. Social Psychol.*, **47**, 169-84 (1958)
12. Biesheuvel, S. Objectives and methods of African psychological research. *J. Social Psychol.*, **47**, 161-68 (1958)
13. Binder, A. Personality variables and recognition response level. *J. Abnormal Social Psychol.*, **57**, 136-42 (1958)
14. Bradway, K. P., Thompson, C. W., and Cravens, R. B. Preschool IQs after twenty-five years. *J. Educ. Psychol.*, **49**, 278-81 (1958)
15. Briggs, P. F. Eight item clusters for use with the M-B history record. *J. Clin. Psychol.*, **15**, 22-28 (1959)
16. Broen, W. E., Jr., and Wirt, R. D. Varieties of response sets. *J. Consulting Psychol.*, **22**, 237-40 (1958)
17. Bryant, J. H., Wurster, C. R., Hine, F. R., and Dawson, J. G. A factorial analysis of behavior ratings of hospitalized mental patients. *J. Psychol.*, **46**, 167-73 (1958)
18. Burke, H. R. Raven's Progressive Matrices: a review and critical evaluation. *J. Genet. Psychol.*, **93**, 199-228 (1958)
19. Burt, C. A note on the theory of intelligence. *Brit. J. Educ. Psychol.*, **28**, 281-89 (1958)
20. Campbell, D. T., and Fiske, D. W. Convergent and discriminant validation by the multitrait-multimethod matrix. *Psychol. Bull.*, **56**, 81-105 (1959)
21. Carroll, J. B., and Sapon, S. M. *Modern Language Aptitude Test* (The Psychological Corporation, New York, N. Y., 1958)
22. Cassel, R. N., and Kahn, T. C. Development and standardization of the Group Personality Projective Test. *J. Projective Techniques*, **22**, 267-71 (1958)
23. Cattell, R. B. Extracting the correct number of factors in factor analysis. *Educ. Psychol. Measurement*, **18**, 791-838 (1958)

24. Cattell, R. B., and Baggaley, A. R. A confirmation of ergic and engram structures in attitudes objectively measured. *Australian J. Psychol.*, 10, 287-318 (1958)
25. Cattell, R. B., Beloff, H., and Coan, R. W. *The IPAT High School Personality Questionnaire* (Institute for Personality and Ability Testing, Champaign, Ill., 1958)
26. Chown, S. M. Personality factors in the formation of occupational choice. *Brit. J. Educ. Psychol.*, 29, 23-33 (1959)
27. Christal, R. E. Factor analytic study of visual memory. *Psychol. Monographs*, 72(13), 24 pp. (1958)
28. Collmann, R. D., and Newlyn, D. Changes in Terman-Merrill IQ's of mentally retarded children. *Am. J. Mental Deficiency*, 63, 307-11 (1958)
29. Comrey, A. L. A factor analysis of items on the K scale of the MMPI. *Educ. Psychol. Measurement*, 18, 633-39 (1958)
30. Conway, J. The inheritance of intelligence and its social implications. *Brit. J. Statist. Psychol.*, 11, 171-90 (1958)
31. Creager, J. A., and Harding, F. D., Jr. A hierarchical factor analysis of foreman behavior. *J. Appl. Psychol.*, 42, 197-203 (1958)
32. Cureton, E. E. The definition and estimation of test reliability. *Educ. Psychol. Measurement*, 18, 715-38 (1958)
33. Davids, A., and Parenti, A. N. Personality social choice, and adults' perception of these factors in groups of disturbed and normal children. *Sociometry*, 21, 212-24 (1958)
34. Davids, A., and Pildner, H., Jr. Comparison of direct and projective methods of personality assessment under different conditions of motivation. *Psychol. Monographs*, 72(11), 30 pp. (1958)
35. Distefano, M. K., Jr., Ellis, N. R., and Sloan, W. Motor proficiency in mental defectives. *Perceptual Motor Skills*, 8, 231-34 (1958)
36. Dole, A. A. The vocational sentence completion blank in counseling. *J. Counseling Psychol.*, 5, 200-5 (1958)
37. Dombrose, L. A., and Slobin, M. S. The IES test. *Perceptual Motor Skills*, 8, 347-89 (1958)
38. Doppelt, J. E., and Seashore, H. G. Psychological testing in correctional institutions. *J. Counseling Psychol.*, 6, 81-92 (1959)
39. Dorfman, E. Personality outcomes of client-centered child therapy. *Psychol. Monographs*, 72(3), 22 pp. (1958)
40. du Mas, F. M. Concept of the intratest and some implications for psychometric theory. *Psychol. Repts.*, 4, 187-92 (1958)
41. du Mas, F. M., and MacBride, K. A manifest structure analysis of the Otis S-A Test of Mental Ability, Higher Examination: Form B. *J. Appl. Psychol.*, 42, 269-72 (1958)
42. Dupont, J. B. La mesure des intérêts appliquée à différents groupes professionnels. *Schweiz. Z. Psychol.*, 18, 42-53 (1959)
43. Edwards, T. B., and Wilson, A. B. The specialization of interests and academic achievement. *Harvard Educ. Rev.*, 28, 183-96 (1958)
44. Eisdorfer, C., Busse, E. W., and Cohen, L. D. WAIS performance of an aged sample: the relationship between verbal and performance IQs. *J. Gerontol.*, 14, 197-201 (1959)
45. Ellis, N. R., and Sloan, W. Relationship between intelligence and skin conductance. *Am. J. Mental Deficiency*, 63, 304-6 (1958)

46. Ellsworth, R. B., and Clayton, W. H. Measurement of improvement in "mental illness." *J. Consulting Psychol.*, **23**, 15-20 (1959)
47. Engelhart, M. D. Obtaining comparable scores on two or more tests. *Educ. Psychol. Measurement*, **19**, 55-64 (1959)
48. Ennis, R. H. An appraisal of the Watson-Glaser critical thinking appraisal. *J. Educ. Research*, **52**, 155-58 (1958)
49. Eysenck, H. J. Review of "Personality and Motivation Structure and Measurement" by Raymond B. Cattell. *Brit. J. Psychol.*, **49**, 350-52 (1958)
50. Fiedler, F. E., Dodge, J. S., Jones, R. E., and Hutchins, E. B. Interrelations among measures of personality adjustment in nonclinical populations. *J. Abnormal Social Psychol.*, **56**, 345-51 (1958)
51. Fine, B. J., and Haggard, D. F. Contextual effects in scaling. *J. Appl. Psychol.*, **42**, 247-51 (1958)
52. Finley, C. J., and Thompson, J. An abbreviated Wechsler Intelligence Scale for Children for use with educable mentally retarded. *Am. J. Mental Deficiency*, **63**, 473-80 (1958)
53. Fisher, R. L. The effect of a disturbing situation upon the stability of various projective tests. *Psychol. Monographs*, **72**(14), 23 pp. (1958)
54. Flanagan, J. C., Fivars, G., and Tuska, S. A. Predicting success in typing and keyboard operation. *Personnel Guidance J.*, **37**, 353-57 (1959)
55. Flanagan, J. C., and Schmid, F. W. The critical incident approach to the study of psychopathology. *J. Clin. Psychol.*, **15**, 136-39 (1959)
56. Forehand, G. A., Jr., and McQuitty, L. L. Configurations of factor standings as predictors of educational achievement. *Educ. Psychol. Measurement*, **19**, 31-43 (1959)
57. Francis, R. J., and Rarick, G. L. Motor characteristics of the mentally retarded. *Am. J. Mental Deficiency*, **63**, 792-811 (1959)
58. Freeman, G. L. A high-level interest-values reference test for counselling pre-retirants. *J. Psychol.*, **46**, 121-39 (1958)
59. Freeman, G. L. Pre-retirant test scores in various hobby groups. *J. Psychol.*, **47**, 137-60 (1959)
60. French, J. L. Intellectual appraisal of physically handicapped children. *J. Genet. Psychol.*, **94**, 131-42 (1959)
61. Fruchter, B., and Novak, E. A comparative study of three methods of rotation. *Psychometrika*, **23**, 211-21 (1958)
62. Fulkerson, S. G. Individual differences in response validity. *J. Clin. Psychol.*, **15**, 169-73 (1959)
63. Gadel, M. S. The relationship of item validity shrinkage to curvilinearity of response distributions. *Educ. Psychol. Measurement*, **18**, 145-52 (1958)
64. Geber, M. The psycho-motor development of African children in the first year, and the influence of maternal behavior. *J. Social Psychol.*, **47**, 185-95 (1958)
65. Gibbens, T. C. N. The Porteus Maze Test and delinquency. *Brit. J. Educ. Psychol.*, **28**, 209-16 (1958)
66. Gibson, D., Jephcott, A. E., and Wilkins, R. Academic success among high grade hospitalized mentally retarded children as a function of intelligence and etiological classification. *Am. J. Mental Deficiency*, **63**, 852-59 (1959)
67. Gibson, J. J., (Ed.) Motion picture testing and research. *Rept. No. 7, AAF Aviation Psychol. Program Research Repts.* (U. S. Govt. Printing Office, Washington, D. C., 267 pp., 1947)

68. Gordon, L. V. Right-handed answer sheets and left-handed testees. *Educ. Psychol. Measurement*, **18**, 783-85 (1958)
69. Graham, E. E., and Kamano, D. Reading failure as a factor in the WAIS sub-test patterns of youthful offenders. *J. Clin. Psychol.*, **14**, 302-4 (1958)
70. Guertin, W. H., and Krugman, A. D. A factor analytically derived scale for rating activities of psychiatric patients. *J. Clin. Psychol.*, **15**, 32-36 (1959)
71. Guttman, L. To what extent can communalities reduce rank? *Psychometrika*, **23**, 297-308 (1958)
72. Heath, R. W. A machine method of computing Guttman's coefficient of reproducibility with a large sample. *J. Appl. Psychol.*, **42**, 204-5 (1958)
73. Higgins, C., and Sivers, C. H. A comparison of Stanford-Binet and Colored Raven Progressive Matrices IQ's for children with low socioeconomic status. *J. Consulting Psychol.*, **22**, 465-68 (1958)
74. Hill, G. E., and Hole, R. M. Comparison of the vocational interests of tenth grade students with their parents' judgments of these interests. *Educ. Psychol. Measurement*, **18**, 173-87 (1958)
75. Hirt, M. Use of the General Aptitude Test Battery to determine aptitude changes with age and to predict job performance. *J. Appl. Psychol.*, **43**, 36-39 (1959)
76. Holland, J. L. A personality inventory employing occupational titles. *J. Appl. Psychol.*, **42**, 336-42 (1958)
77. Honkavaara, S. Organization process in perception as a measure of intelligence. *J. Psychol.*, **46**, 3-12 (1958)
78. House, B. J., and Zeaman, D. Visual discrimination learning in imbeciles. *Am. J. Mental Deficiency*, **63**, 447-52 (1958)
79. Howell, R. J., Evans, L., and Downing, L. N. A comparison of test scores for the 16-17-year age group of Navaho Indians with standardized norms for the Wechsler Adult Intelligence Scale (Arizona and New Mexico). *J. Social Psychol.*, **47**, 355-59 (1958)
80. Hunt, B., and Patterson, R. M. Performance of brain-injured and familial mentally deficient children on visual and auditory sequences. *Am. J. Mental Deficiency*, **63**, 72-80 (1958)
81. Indow, T. The mental growth curve defined on the absolute scale: comparison of Japanese and foreign data. *Japan Psychol. Research*, No. 6, 35-48 (1958)
82. Izard, C. E. Paranoid schizophrenic and normal subjects' perceptions of photographs of human faces. *J. Consulting Psychol.*, **23**, 119-24 (1959)
83. Izard, C. E. Personality correlates of sociometric status. *J. Appl. Psychol.*, **43**, 89-93 (1959)
84. Jackson, D. N., and Messick, S. Content and style in personality assessment. *Psychol. Bull.*, **55**, 243-52 (1958)
85. Jastak, J. F. *The Jastak Test of Potential Ability and Behavior Stability* (Educational Test Bureau, Nashville, Tenn., 1958)
86. Jowett, G. H. Factor analysis. *Appl. Statist.*, **7**, 114-25 (1958)
87. Kahn, M. W. A comparison of personality, intelligence, and social history of two criminal groups. *J. Social Psychol.*, **49**, 33-40 (1959)
88. Kaiser, H. F. The varimax criterion for analytic rotation in factor analysis. *Psychometrika*, **23**, 187-200 (1958)
89. Karon, B. P. *The Negro Personality: a Rigorous Investigation of the Effects of Culture* (Springer Publishing Co., Inc., New York, N. Y., 184 pp., 1958)

90. Kerman, E. F. Cypress knees and the blind. *J. Projective Techniques*, **23**, 49-56 (1959)
91. Kirk, S. A., *Early Education of the Mentally Retarded: an Experimental Study* (The University of Illinois Press, Urbana, Ill., 216 pp., 1958)
92. Klausmeier, H. J., and Check, J. Relationships among physical, mental, achievement, and personality measures in children of low, average, and high intelligence at 113 months of age. *Am. J. Mental Deficiency*, **63**, 1059-68 (1959)
93. Kralovich, A. M. A study of performance differences on the Cattell Infant Intelligence Scale between matched groups of organic and mongoloid subjects. *J. Clin. Psychol.*, **15**, 198-99 (1959)
94. Lawley, D. N. Estimating in factor analysis. *Brit. J. Statist. Psychol.*, **11**, 1-12 (1958)
95. Lederman, D. G. Small group observation as a diagnostic technique. *Am. J. Mental Deficiency*, **63**, 64-71 (1958)
96. Leiter, R. G. Part I of the manual for the 1948 revision of the Leiter International Performance Scale. *Psychol. Serv. Center J.*, **11**, 1-72 (1959)
97. Lesser, G. S. Application of Guttman's scaling method to aggressive fantasy in children. *Educ. Psychol. Measurement*, **18**, 543-51 (1958)
97. Lesser, G. S. Application of Guttman's scaling method to aggressive fantasy in children. *Educ. Psychol. Measurement*, **18**, 543-51 (1958)
98. Lesser, G. S. Population differences in construct validity. *J. Consulting Psychol.*, **23**, 60-65 (1959)
99. Levine, M., Spivack, G., Fuscillo, J., and Tavernier, A. Intelligence and measures of inhibition and time sense. *J. Clin. Psychol.*, **15**, 224-26 (1959)
100. Levinson, B. M. Re-evaluation of the revised Stanford-Binet scale, Form L vocabulary as a test of intelligence for the kindergarten and primary school child. *J. Genet. Psychol.*, **93**, 237-48 (1958)
101. Liddle, G. Overlap among desirable and undesirable characteristics in gifted children. *J. Educ. Psychol.*, **49**, 219-23 (1958)
102. Lienert, G. A. Ein Test zur beurteilung des mechanischtechnischen Verstandnisses. *Z. exptl. angew. Psychol.*, **5**, 605-20 (1958)
103. Lindzey, G. On the classification of projective techniques. *Psychol. Bull.*, **56**, 158-68 (1959)
104. Lipman, R. S. Some test correlates of behavioral aggression in institutionalized retardates with particular reference to the Rosenzweig Picture-Frustration Study. *Am. J. Mental Deficiency*, **63**, 1038-45 (1959)
105. Liverant, S. The use of Rotter's social learning theory in developing a personality inventory. *Psychol. Monographs*, **72**(2), 23 pp. (1958)
106. Lord, F. M. Some relations between Guttman's principal components of scale analysis and other psychometric theory. *Psychometrika*, **23**, 291-96 (1958)
107. Lord, F. M. The utilization of unreliable difference scores. *J. Educ. Psychol.*, **49**, 150-52 (1958)
108. Lord, F. M. Statistical inferences about true scores. *Psychometrika*, **24**, 1-17 (1959)
109. Lotsof, E. J., Comrey, A., Bogartz, W., and Arsfield, P. A factor analysis of the WISC and Rorschach. *J. Projective Techniques*, **22**, 297-301 (1958)
110. Masland, R. L. The prevention of mental retardation: a survey of research. *Am. J. Mental Deficiency*, **62**, 991-1112 (1958)
111. Masland, R. L., Sarason, S. B., and Gladwin, T. *Mental Subnormality: Bio-*

- logical, Psychological and Cultural Factors* (Basic Books, Inc., New York, N. Y., 422 pp., 1959)
112. Manhold, J. H., Jr., and Hafner, A. J. Dental caries and psychological factors. *J. Clin. Psychol.*, **14**, 319-20 (1958)
 113. Maxwell, A. E. Statistical methods in factor analysis. *Psychol. Bull.*, **56**, 228-35 (1959)
 114. McCord, W. M., and Demerath, N. J., III. Negro versus white intelligence: a continuing controversy. *Harvard Educ. Rev.*, **28**, 120-35 (1958)
 115. McGurk, F. C. J. "Negro vs. white intelligence"—an answer. *Harvard Educ. Rev.*, **29**, 54-62 (1959)
 116. McQuitty, L. L. Developing pattern-analytic methods to isolate fruitful psychological concepts. *Can. J. Psychol.*, **12**, 109-14 (1958)
 117. McQuitty, L. L. Job-knowledge scoring keys by item versus configural analysis for assessing levels of mechanical experience. *Educ. Psychol. Measurement*, **18**, 661-80 (1958)
 118. Merenda, P. F., and Clarke, W. V. AVA as a predictor of occupational hierarchy. *J. Appl. Psychol.*, **42**, 289-92 (1958)
 119. Merenda, P. F., and Clarke, W. V. Test-retest reliability of Activity Vector Analysis. *Psychol. Repts.*, **5**, 27-30 (1959)
 120. Metfessel, N. S., and Sax, G. Systematic biases in the keying of correct responses on certain standardized tests. *Educ. Psychol. Measurement*, **18**, 787-90 (1958)
 121. Michael, W. B., Wrigley, C., Tryon, R. C., and Guttman, L. Symposium: the future of factor analysis. *Educ. Psychol. Measurement*, **18**, 455-515 (1958)
 122. Molish, H. B. Contributions of projective tests to problems of psychological diagnosis in mental deficiency. *Am. J. Mental Deficiency*, **63**, 282-93 (1958)
 123. Mosak, H. H. Early recollections as a projective technique. *J. Projective Techniques*, **22**, 302-11 (1958)
 124. Muldoon, J. F., and Ray, O. S. A comparison of pattern similarity as measured by six statistical techniques and eleven clinicians. *Educ. Psychol. Measurement*, **18**, 775-81 (1958)
 125. Mundy-Castle, A. C. Electrophysiological correlates of intelligence. *J. Personality*, **26**, 184-99 (1958)
 126. Newman, R. E. Personality development in a primitive "adolescent" group. *Z. diagnost. Psychol.*, **6**, 241-53 (1958)
 127. Newstrand, M. B. The eavesdropping questions: a new projective technique to aid in determining self-image. *J. Projective Techniques*, **22**, 312-19 (1958)
 128. Nisbet, J., and Buchan, J. The long-term follow-up of assessments at age eleven. *Brit. J. Educ. Psychol.*, **29**, 1-8 (1959)
 129. Nunnally, J., and Husek, T. R. The phony language examination: an approach to the measurement of response bias. *Educ. Psychol. Measurement*, **18**, 275-82 (1958)
 130. Okarski, J. F. Consistency of projective movement responses. *Psychol. Monographs*, **72**(6), 26 pp. (1958)
 131. Oliver, J. N. The effect of physical conditioning exercises and activities on the mental characteristics of educationally sub-normal boys. *Brit. J. Educ. Psychol.*, **27**, 155-65 (1958)
 132. Ombredane, A., Bertelson, P., and Beniast-Noirot, E. Speed and accuracy of

- performance of an African native population and of Belgian children on a paper-and-pencil percept test. *J. Social Psychol.*, **47**, 327-37 (1958)
133. Orme, J. E. Rorschach performances in normal old age, elderly depression and senile dementia. *Z. diagnost. Psychol.*, **6**, 132-41 (1958)
 134. Pascal, G. R., and Jenkins, W. O. The Hunter-Pascal concept formation test: an experimental approach to the measurement of cortical capacity. *J. Clin. Psychol.*, **15**, 159-63 (1959)
 135. Peters, H. N. A multiple choice supraordinality test. *J. Clin. Psychol.*, **14**, 416-18 (1958)
 136. Peterson, D. W., Quay, H. C., and Anderson, A. C. Extending the construct validity of a socialized scale. *J. Consulting Psychol.*, **23**, 182 (1959)
 137. Petrovich, D. V. The Pain Apperception Test: psychological correlates of pain perception. *J. Clin. Psychol.*, **14**, 367-74 (1958)
 138. Pettigrew, T. F. The measurement and correlates of category width as a cognitive variable. *J. Personality*, **26**, 532-44 (1958)
 139. Pichot, P. Les méthodes dans l'emploi des tests mentaux en psychopathologie. *Bull. psychol.*, **12**, 294-98 (1959)
 140. Pierce-Jones, J. Vocational interest correlates of socio-economic status in adolescence. *Educ. Psychol. Measurement*, **19**, 65-71 (1959)
 141. Plant, W. T., and Richardson, H. The IQ of the average college student. *J. Counseling Psychol.*, **5**, 229-31 (1958)
 142. Plant, W. T., and Lynd, C. A validity study and a college freshman norm group for the Wechsler Adult Intelligence Scale. *Personnel Guidance J.*, **37**, 578-80 (1959)
 143. Porteus, S. D. What do the maze tests measure? *Australian J. Psychol.*, **10**, 245-56 (1958)
 144. Reitan, R. M. Validity of the trail making test as an indicator of organic brain damage. *Perceptual Motor Skills*, **8**, 271-76 (1958)
 145. Rusmore, J. T. A note on the test of "practical judgment." *Personnel Psychol.*, **11**, 37 (1958)
 146. Sarason, S. B., and Gladwin, T. Psychological and cultural problems in mental subnormality: a review of research. *Genet. Psychol. Monographs*, **57**, 3-289 (1958)
 147. Schaie, K. W. Rigidity-flexibility and intelligence: a cross-sectional study of the adult life span from 20 to 70 years. *Psychol. Monographs*, **72**(9), 26 pp. (1958)
 148. Schmid, J., and Leiman, J. M. The development of hierarchial factor solutions. *Psychometrika*, **22**, 53-61 (1957)
 149. Schultz, R. E. Factorial validity of the Holzinger-Crowder Uni-Factor Tests. *Educ. Psychol. Measurement*, **18**, 873-75 (1958)
 150. Sehringer, W. Der Goodenough-Test. *Psychol. Forsch.*, **25**, 155-237 (1957)
 151. Sells, S. B. Structural measurement of personality and motivation: a review of contributions of Raymond B. Cattell. *J. Clin. Psychol.*, **15**, 3-21 (1959)
 152. Semeonoff, B., and Trist, E. *Diagnostic Performance Tests: A Manual for Use with Adults* (Tavistock, London, England, 176 pp., 1958)
 153. Sen, T. K., and Kundu, R. Development of a new introversion-extraversion inventory. *Psychologia*, **1**, 257-64 (1958)
 154. Sharp, H. C. A note on the reliability of the Leiter International Performance Scale. *J. Consulting Psychol.*, **22**, 320 (1958)
 155. Shuey, A. M. *The Testing of Negro Intelligence* (J. P. Bell, Lynchburg, Va., 351 pp., 1958)

156. Smith, D. D. Abilities and interests: I. A factorial study. *Can. J. Psychol.*, **12**, 191-201 (1958)
157. Smith, D. D. Abilities and interests: II. Validation of factors. *Can. J. Psychol.*, **12**, 253-58 (1958)
158. Smith, G., and Marke, S. The influence on the results of a conventional personality inventory by changes in the test situation: a study on the Humm-Wadsworth Temperament Scale. *J. Appl. Psychol.*, **42**, 227-33 (1958)
159. Sokal, R. R. Thurstone's analytical method for simple structure and a mass modification thereof. *Psychometrika*, **23**, 237-58 (1958)
160. Stanek, R. J. A note on the presumed measures of masculinity-femininity. *Personnel Guidance J.*, **37**, 439-40 (1959)
161. Stilson, D. W., Mason, D. J., Gynther, M. D., and Gertz, B. An evaluation of comparability and reliabilities of two behavior rating scales for mental patients. *J. Consulting Psychol.*, **22**, 213-16 (1958)
162. Stone, J. B. *S-O Rorschach Test* (California Test Bureau, Los Angeles, Calif., 1959)
163. Strupp, H. H. The performance of psychiatrists and psychologists in a therapeutic interview. *J. Clin. Psychol.*, **14**, 219-26 (1958)
164. Stuckert, R. P. A configurational approach to prediction. *Sociometry*, **21**, 225-37 (1958)
165. Symonds, P. M. An educational interest inventory. *Educ. Psychol. Measurement*, **18**, 377-85 (1958)
166. Talmadge, M. Expressive graphic movements and their relationship to temperament factors. *Psychol. Monographs*, **72**(16), 30 pp. (1958)
167. Thurstone, L. L. *The Measurement of Values* (The University of Chicago Press, Chicago, Ill., 322 pp., 1959)
168. Torgerson, W. S. *Theory and Methods of Scaling* (John Wiley and Sons, New York, N. Y., 460 pp., 1958)
169. Tryon, R. C. Cumulative communality cluster analysis. *Educ. Psychol. Measurement*, **18**, 3-35 (1958)
170. Tucker, L. R. An inter-battery method of factor analysis. *Psychometrika*, **23**, 111-36 (1958)
171. Tupes, E. C., Carp, A., and Borg, W. R. Performance in role-playing situations as related to leadership and personality measures. *Sociometry*, **21**, 165-79 (1958)
172. Tyler, L. E. The stability of patterns of primary mental abilities among grade school children. *Educ. Psychol. Measurement*, **18**, 769-74 (1958)
173. Tyler, L. E. Toward a workable psychology of individuality. *Am. Psychologist*, **14**, 75-81 (1959)
174. Verhaegen, P., and Laroche, J. L. Some methodological considerations concerning the study of aptitudes and the elaboration of psychological tests for African natives. *J. Social Psychol.*, **47**, 249-56 (1958)
175. Vernier, C. M., Stafford, J. W., and Krugman, A. D. A factor analysis of indices from four projective techniques associated with four different types of physical pathology. *J. Consulting Psychol.*, **22**, 433-37 (1958)
176. Vernon, P. E. Education and the psychology of individual differences. *Harvard Educ. Rev.*, **28**, 91-104 (1958)
177. Voas, R. B. A procedure for reducing the effects of slanting questionnaire responses toward social acceptability. *Educ. Psychol. Measurement*, **18**, 337-45 (1958)

178. Voas, R. B. Vocational interests of naval aviation cadets: final results. *J. Appl. Psychol.*, **43**, 70-73 (1959)
179. Walters, R. H. The intelligence test performance of Maori children: a cross-cultural study. *J. Abnormal Social Psychol.*, **57**, 107-14 (1958)
180. Walters, R. H., and Zaks, M. S. Validation studies of an aggression scale. *J. Psychol.*, **47**, 209-18 (1959)
181. Watts, K. P. Intelligence test performance from 11 to 18: a study of grammar school girls. *Brit. J. Educ. Psychol.*, **28**, 112-19 (1958)
182. Webster, H. A forced-choice figure preference test based on factorial design. *Educ. Psychol. Measurement* **19**, 45-54 (1959)
183. Weingarten, K. P. *Picture Interest Inventory* (California Test Bureau, Los Angeles, Calif., 1959)
184. Wherry, R. J. Hierarchical factor solutions without rotation. *Psychometrika*, **24**, 45-51 (1959)
185. Whitcomb, M. A. The IBM answer sheet as a major source of variance on highly speeded tests. *Educ. Psychol. Measurement*, **18**, 757-59 (1958)
186. Wiens, A. N., Matarazzo, J. D., and Gaver, K. D. Performance and verbal IQ in a group of sociopaths. *J. Clin. Psychol.*, **15**, 191-93 (1959)
187. Williams, W. C. The PALS tests: a technique for children to evaluate both parents. *J. Consulting Psychol.*, **22**, 487-95 (1958)
188. Witryol, S. L., and Kaess, W. A. Individual differences in perception of synthetic speech. *Preceptual Motor Skills*, **8**, 215-18 (1958)
189. Wölker, H. Erfahrungen mit einer filmisch dargebotenen Version des TAT. *Z. diagnost. Psychol.*, **6**, 121-31 (1958)
190. Wrigley, C., Saunders, D. R., and Neuhaus, J. O. Application of the quartimax method of rotation to Thurstone's primary mental abilities study. *Psychometrika*, **23**, 151-70 (1958)
191. Yeslin, A. R., Vernon, L. N., and Kerr, W. A. The significance of time spent in answering personality inventories. *J. Appl. Psychol.*, **42**, 264-66 (1958)
192. Zaks, M. S., and Walters, R. H. First steps in the construction of a scale for the measurement of aggression. *J. Psychol.*, **47**, 199-208 (1959)

PERSONALITY DYNAMICS^{1,2}

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This is the first annual review of theory and research in the field of personality to be given the restricted title. "Personality Dynamics." In the initial volume of this annual, Sears (138) presented a useful conception of the three focal problems in the domain of "personality": the problem of development, the problem of contemporary dynamics, and the problem of structure. The present chapter, following the intention of its title, will consider only research which deals primarily with the problem of contemporary dynamics. It must of necessity (and with apology) be selective in treating what the writer considers the core of the effort to clarify the theoretical conception of the interaction of personality and situation, the process of motivation and resolution of conflict, manifestations of personality dispositions in cognition and action, and the differences between conscious and unconscious processes.

With the vast yearly increase of research within each of the three approaches to personality, the ideal of integration and suggestions as to how it may be attained should command greater attention than ever before. Our progress is slow because we have not really clarified the different intentions and assumptions which characterize the three special provinces, nor, it seems, have we thoroughly considered what is required for the efforts of each to be integrated.

The viewpoint defined by the title of this chapter and entertained by the writer sees the primary task as that of developing a useful conceptual scheme to account for the contemporary dynamics of action in the human adult. Lewin's (83) familiar programmatic writings, viz., the equation $B=f(P, E)$, and sections of an earlier review by Bronfenbrenner (20) call attention to the need for clarity in the conception of how inferred dispositions of the person interact with momentary environmental influences to determine the reportable cognitions and overt actions which constitute the observed manifestations of personality. According to this view, clarification of the contemporary process of motivation in the human adult—broadly conceived as the invention of a useful conception of the variables to be taken into account and a principle to show how they combine to influence behavior—is considered the essential first task in the study of personality. The

¹ This review considers research published between April, 1958 and April, 1959 and appropriate background references.

² The following abbreviations are used: S (subject); MAS (Manifest Anxiety Scale); TAQ (Test Anxiety Questionnaire); TAT (Thematic Apperception Test); PPS (Personal Preferences Schedule); n (Murray's abbreviation for "need for" or "motive for," e.g., n. Achievement); GSR (galvanic skin reaction); SD (Social Desirability).

word "useful" should be emphasized to show that our current need is not so much for speculative ideas or vague programmatic schemes, of which there is already a plethora, as it is for concepts and schemes that refer unambiguously to the kinds of factual evidence we have found it possible to obtain from test scores and experimental observations, or that lead to the creation of new methods of study.

It can be argued from this viewpoint that no principle concerning the way the strength of some inferred disposition of personality is changed by learning experience can even be tested without a prior statement of how that disposition (now with a change in its strength) will be activated or inhibited by momentary situational factors, and how its influence will combine with that of other activated dispositions at the very moment one wishes to make observations of behavior to test for the presumed effect of the learning experience. It can also be argued that another prerequisite for meaningful research on the development and change of personality is the identification of the kinds of dispositions that are sufficiently important in adult human affairs to deserve taking account of in the theory of how personality develops. This might seem an open invitation to begin with factor analysis of behavioral expressions of personality were it not for the obvious failure of the static assessment approach to come to grips with the complexity of interactions between personality dispositions and momentary environmental influences. If—and by now there is no question about it—personality dispositions and momentary environmental influences combine in complex ways to influence behavior (i.e., a test behavior), how can complex statistical operations clarify the meaning of matrices of correlations among test behavior scores before the important contemporaneous environmental influences have been sufficiently identified and understood at least to be controlled and described as subscripts in the matrix of correlations? Allport reflects this position in a comment concerning the baffling array of characteristics that are often found to hang together defining the factors in some factorial studies: "When units of this sort appear—and I submit that it happens not infrequently—one wonders what to say about them. To me they resemble sausage meat that has failed to pass the pure food and health inspection" (2, p. 251). And Hebb has similarly concluded: "Factor analysis remains a powerful tool for simplifying correlational data, but it now seems clearly not to be a means of discovery, and it is not reasonable to expect that it can transcend the limitations of the original test data or be a substitute for new experimental analyses" (57, p. 456).

These, then, are the kinds of arguments defining the place of research which attempts to clarify the contemporary dynamics of motivation-conflict-action by close scrutiny of the interaction between certain variables tentatively considered general characteristics of the individual personality and certain other variables tentatively considered specific reactions to the momentary environment which the individual confronts. The task is to develop a testable statement (a principle) of how these two sets of variables

combine to produce the variety of behaviors which must always be considered and studied as manifestations of interaction between dispositions of personality and momentary environmental influences.

CONCEPTIONS OF PERSONALITY—ENVIRONMENT INTERACTION

This pattern in the development of ideas about personality dynamics is apparent in current work on a number of important substantive problems. The interactive effects of early-acquired predispositions of personality and critical life experiences in adulthood is the subject of two important contributions by Janis. Janis (64) presents a sound analysis of the unexploited research potentialities of the psychoanalytic interview as a unique observational method for the study of the dynamics of unconscious motives, conflicts, defenses, and other inferred mediational processes which are instigated by certain critical life experiences like separation from loved ones, career failures, or a sudden loss of status. In a book entitled *Psychological Stress* (63), he provides an illustration of the manner in which careful documentation of the details of psychoanalytic interviews made it possible to capitalize on the natural experiment provided when the necessity of major surgery arose for a neurotic female client during the course of psychoanalytic treatment. Janis, concentrating his effort on discovering unconscious factors that might enter into typical reactions to external stress, develops a number of explicit hypotheses. A general assumption runs through the theoretical discussion, which is constantly linked to observations recorded during psychoanalytic interviews: "... stress experiences tend to arouse apparently outgrown modes of response to childhood dangers. The primitive affects, fantasies, and defenses that had become habitual ways of adjusting to external threats during the early years of a person's life, although partially superseded by new habits, remain latent reaction tendencies in the adult personality. The latent tendencies will be called forth once again whenever powerful threat stimuli are encountered" (63, p. 53).

Janis follows his intensive analysis of the neurotic woman with the report of supplementary behavioral research: case studies of patients hospitalized in surgical wards who were interviewed intensively before and after their operations, and a questionnaire survey dealing with the emotional impact of surgical experiences conducted among several hundred male adolescents who had undergone operations recently. His results show the average temporal course of reported fear response, increasing from the preoperative period to a peak in the operating room and then decreasing following the operation, which is a direct parallel to the temporal course of fear-related motivation manifested by soldiers in thematic apperception in relation to an atomic explosion, as was brought out in a study conducted by Walker *et al.* (156). Of particular interest is the fact that those who report a moderate (or realistic) amount of fear before an operation are least emotionally disturbed after the operation. Those who report exaggerated fears before the operation (i.e., the neurotically anxious) continue to display a relatively high level of

fear after the operation, along with strong affiliative and compliant behaviors. However, those who are very low in anticipatory fear, who, instead, approach the operation with overly optimistic expectations which constitute a defensive denial or minimization of the anticipated danger and suffering, tend to react with angry resentment after the operation and persist in their negative emotional reaction to the operation and those connected with it. Janis considers the anger and resentment of this group a regressive aggrievement-reaction of childlike rage or depression, or both, which occurs when defensive denial of the threat prevents the individual from preparing himself through the "work of worrying" (his concept) for the painful reality experience which ensues. In addition to providing an exemplary model of research which exploits the unique values of several different observational methods, particularly the psychoanalytic interview, Janis provides an illustration of how the person-environment interaction is conceived and described in the language of experiential states (but with numerous hints for a stimulus-response formulation) within the framework of psychoanalytic theory.

Blum (17), also addressing himself to the ahistorical problems with a psychoanalytic orientation, has presented a preliminary formulation of a theoretical model which borrows conceptual operations like scanning, mixing, and amplification from electronics to specify more clearly the nature of the complex unconscious processes which occur between stimulus input and behavioral output.

The analysis of interaction between personality and environment is most advanced in research on the problem of personality dynamics, which has the longest experimental history [see, for example, Lewin (82), Rosenzweig (127), Sears (135, 136, 137)]. Much work has been done in the study of how an individual thinks, feels, and acts when in a situation requiring him to perform some task when he knows that his skill and competence will be evaluated against socially defined standards of excellence and when he also knows (in common sense terms) that a good performance will produce the feeling (pride) which accompanies success and a bad performance will produce the feeling (shame or embarrassment) that accompanies failure.

Added to the many studies of the effects of individual differences in strength of anxiety or in Achievement is a growing interest in the analysis of factors directly related to the evaluation of performance. Gerard (52) has found that Ss tend to overvalue their own performance under conditions which heighten their desire to perform well. Howard & Berkowitz (61) have studied the reactions of S to an observer who disagrees with a panel of others in evaluating S's performance. The authors find that S questions the credibility of the deviant judge, whether he is more positive or negative than the panel in his evaluations. They interpret this to mean that the desire for accurate evaluation outweighs the desire for self-enhancement. Baldwin & Levin (9, 80) have begun to study the conditions under which children will choose to exhibit the products of their achievement performances to others.

There is substantial experimental evidence concerning the interactive

effects on performance of experimentally controlled factors and assessed individual differences in the strength of inferred anxiety disposition. This evidence comes from studies which have employed the Manifest Anxiety Scale (MAS) and the Test Anxiety Questionnaire (TAQ) [see Child (27), Spence (141), Taylor (146)].

Another substantial fund of experimental evidence pertaining to interactive effects on performance has developed as a consequence of interest in the tendency assessed by thematic apperceptive techniques, and called the achievement motive, which is reviewed this year in *Motives in Fantasy, Action, and Society* (7). The evidence from these two programs of research activity, i.e., on anxiety and on TAT n-Achievement, is obviously on the verge of integration, for each contains within it the solution to the most stubborn problem faced by the other. The clash of theoretical ideas in research on "success and failure" highlights the general debate going on within contemporary psychology concerning the theoretical conception of motivation, which has direct relevance for all research on personality.

Investigators have sensed that research findings concerning n-Achievement and the anxiety scales ought to be integrated. Raphelson (122) and Raphelson & Moulton (123) have scrutinized the interrelationships among TAT n-Achievement scores, MAS, TAQ, and psychogalvanic response obtained under different achievement-oriented conditions, finding that relationships between these variables are influenced by changes in experimental conditions. Bendig (10) has found apperceptive n-Achievement scores uncorrelated with either MAS or Edwards Personal Preference Schedule (PPS) n-Achievement scores. Kausler & Trapp (69) have reported a correlation of $-.20$ between n-Achievement scores derived from the French Test of Insight (48) and MAS in a group of 103 men. Several other studies at Michigan (8, 90, 94) have uncovered no relationship between Test Anxiety and TAT n-Achievement scores obtained under neutral conditions.

Anxiety drive.—The two most widely known theoretical conceptions of the personality environment interaction in the achievement performance situation are based on the "S-R drive drive-reduction" theory. One of these, espoused by Taylor (146), Spence (141), and other researchers in the Iowa tradition, focuses upon the nondirective energizing function assigned to drive (D) in Hullian theory in relation to the individual's habitual response tendencies (sHr) that are elicited by the internal and external stimuli present in a given situation. The measure of manifest anxiety (MAS) yields two extreme groups conceived to be differentially disposed to be driven by anxiety (i.e., emotionally aroused) when under stressful circumstances. It is assumed that individuals have learned to respond with fear (an acquired drive) in achievement test situations as well as in other situations which threaten "noxious" consequences. It is acknowledged that internal stimuli which distinguish the fear response (S_d) and external cues (S_e), including those inherent in the task itself, may elicit a variety of different previously learned habits (sHr's). When one of these habits is prepotent by virtue of either fewer

stimuli in the environment (as in a simple task which elicits only one sHr) or by virtue of prior differential training, then higher anxiety (stronger drive) should enhance performance ($D \times sHr = \text{reaction potential}$). However, when more environmental stimuli are present to elicit more and potentially incompatible habits (as in a complex task), particularly when prior training has not clearly made one habit prepotent for the stimulus situation, then higher anxiety (stronger drive) should produce more conflict between simultaneously activated response tendencies and, consequently, a decrement in performance of "correct" responses. Mandler & Sarason (98) developed the TAQ to tap the disposition to be anxious that is specifically elicited in a restricted class of situations, i.e., achievement test situations. These authors and Child (27), while cognizant of the nondirective energizing function of drive in S-R drive theory, have emphasized in their conceptions of what processes take place when differential anxiety is aroused the selective, or steering, function of the distinctive internal stimuli (S_d) that accompany and identify the fear response. The internal cues accompanying the arousal of the fear response are said to elicit many different kinds of "task-irrelevant" responses which in the past have been reinforced by reduction of fear. According to this conception of the problem, task-irrelevant ("avoidant") habits are more strongly aroused in the highly anxious S. These tendencies conflict with the task-relevant tendency, which must also be conceived as an avoidant tendency, producing a decrement in performance of task-relevant responses.

Neither of these schemes can explain very convincingly why the performance of persons low in assessed anxiety-disposition has been found to be enhanced by so-called ego-involving, threatening, or stressful situational cues. Mandler & Sarason (98), Sarason, Mandler & Craighill (132), and Lucas (93), for example, found that Ss low in anxiety showed better performance under more test-like than neutral performance conditions. And, this year, Katchmar, Ross & Andrews (67) report no difference in performance of high- and low-anxiety groups before failure stress, but, afterwards, when the high-anxiety group shows the expected decrement, the low-anxiety group shows an increment in performance. Why? Whichever of the theoretical conceptions is preferred, the consequence of increased situational arousal of anxiety drive should be to produce either more drive-induced conflict or the elicitation of more task-irrelevant avoidance responses and, consequently, some decrement, albeit a smaller one, in the performance of low-anxiety groups.

The achievement motive.—Paradoxically, research centering on the use of thematic apperception (3, 7, 103, 104, 126) and a modified apperceptive test devised by French (48) to assess strength of n Achievement has always focused on the normal increment or enhancement of performance accompanying achievement orientation or "threat" shown by Ss who are high in n Achievement as the fact of primary theoretical interest [see also (50)]. Observed decrements or inefficiency in memory (112), perception (113), or performance level (103) among persons described as low in n Achievement have generally been viewed as a subsidiary finding implying an unmeasured fear of

failure in Ss not otherwise highly motivated to achieve. Continued experimental analysis of the relationship of n-Achievement scores to memory, perceptual responses, performance level, and, more recently, to level of aspiration or risk-taking behavior (7, Part III) has produced a theoretical conception of what is happening in the situation in which an individual's performance is evaluated. It may be considered an alternative to the conceptions of motivation carried over to this problem from experimental analysis of fear as an acquired drive in lower animals. The theoretical conception, which borrows most from Tolman (149, 150), is an adaptation of what might, for brevity, be called the "expectancy-value theory" that has become increasingly apparent in a variety of independent domains of research.

Why consider "expectancy-value" theory?—In a lucid contribution to theoretical integration, Feather (43) has focused attention on the frequent use of what is here called "expectancy-value" theory. He uncovers the fundamental conceptual equivalence which lurks behind the use of different verbal labels in what so often are considered widely divergent fields of research—in the Lewinian (23, 83) conception of the determinants of approach and avoidance forces, particularly in the treatment of level of aspiration (84); in Tolman's (150) conception of the factors which together influence the purposive performance vector of rats; in Rotter's (128) conception of behavioral potential as a function of expectancy and reinforcement value in analysis of behavioral problems in the field of personality and clinical psychology; in the conception of subjectively expected utility as a function of subjective probability and utility in the mathematical models of decision considered by Edwards (38) and others; in his own conception of choice potential; and in Atkinson's (6, 7) conception of achievement motivation and anxiety about failure. The same theoretical ideas are also apparent in the analysis and measurement of uncertainty and subjective probability-phenomena by Cohen (29) and his co-workers.

The plausibility of this alternative theory of contemporaneous motivation, which can accommodate the qualitative distinction between what common sense calls "pleasure-seeking" and "pain-avoiding," and which focuses primarily on cognitive expectations of rewarding or punishing consequences of actions, is heightened when one considers recent physiological and animal-behavioral evidence that has shaken the foundation of the drive theory of motivation during the past decade. Many researchers who continue to lean on a homeostatic drive conception as a foundation for their research on personality dynamics either ignore or conveniently overlook evidence, like that of Olds (116, 117), which clearly refutes the notion that the goal of all behavior is reduction of excitation. Olds has shown that rats will do all the things "motivated" animals are supposed to do, including learning complex routes to a goal box, when their only reward is to press a lever which increases the level of stimulation in certain areas of the brain. They show, in Tolman's terms, "purposive" pursuit of increased stimulation. This work adds to evidence accumulated by Young (158) on positive affective arousal in appetitive

behavior and other critical behavioral evidence [reviewed in (103)] which clearly suggests that positive emotional conditioning should be given a status equal to that of negative emotional conditioning in the theory of genesis of motives. There is also a fast-growing fund of factual information about so-called intrinsic motivation (54, 76) in lower animals (i.e., curiosity, exploration, manipulation) further to shake confidence in the belief that all of the motives of human adults must necessarily be considered historical derivatives of a handful of homeostatic mechanisms. A belief in the potential adequacy of drive theory can no longer be sustained simply by arguing an absence of evidence to the contrary in lower animals.

As a consequence, we find ourselves in a period of conceptual transition of immediate relevance for most research on personality. Within S-R behavior theory, Spence (140, 142) is reformulating the conception of motivation in the Hullian equation, giving primary attention to what is called "incentive motivation." The positive anticipatory goal response (appetite) has finally come to the forefront as equal in importance to the negative anticipatory emotional response (anxiety) as a motivator of behavior. The necessity of a nondirective energizer conception of motivation, challenged earlier by various writers (e.g., 18), has been virtually written off in a brilliant theoretical essay by Estes (41), which shows how the internal cues produced by states of deprivation can effectively carry the burden of explaining activation of behavior without the additional postulate of an activating drive. Other investigators with similar ideas, Birch, Burnstein & Clark (13), have presented experimental evidence to support their argument that the only effect of depriving an animal of food may be to heighten the arousal of the anticipatory goal reaction previously conditioned to the distinguishable internal cues which accompany food privation. In other words, time of deprivation may be considered an experimental operation by which what Spence calls incentive motivation (the anticipatory goal reaction) is aroused. And Miller, agreeing with the kinds of suggestions advanced earlier by critics of the drive concept, has pointed out that an important implication of his assumption that all "drives" be considered strong stimuli is that "drive generalization should occur as a special case of stimulus generalization" (110, p. 253) to explain the apparent "nondirective" influence of irrelevant drive conditions on performance.

The impetus for an agonizing reappraisal of theories about human motivation and conflict is provided by Miller (110). He points out that, in its weak form, the drive-reduction hypothesis asserts that a sudden reduction of a strong motivational stimulus always serves as a reward; in its strong form it states that all reward is produced this way, or, in other words, that drive-reduction is not only a sufficient, but also the necessary, condition for reinforcement. In an open-minded review of his theoretical position this year, Miller says:

Although I believe that the foregoing hypothesis has considerably less than a 50 per cent chance of being correct, especially in its strong form, I do believe it is better

at the present moment than any other single hypothesis. Therefore, I feel that it is worthwhile to try out applying it consistently, if only to highlight the obstacles and infuriate others into devising superior hypotheses and the experimental programs to support them.

He further states:

The stimulus-reduction hypothesis of reinforcement could be discarded without having an appreciable effect on the rest of my theoretical formulations. I take this occasion to urge attempts to formulate and rigorously test competing hypotheses, and time permitting, may even join in that activity myself. However unsatisfactory, the drive-reduction hypothesis is not likely to be abandoned as long as it is the best thing of its kind that we have. The decisive way to kill it is with a superior alternative (110, pp. 256-57).

In the concluding chapter of a symposium devoted to review of the biological and chemical bases of behavior, Hebb presents an even more urgent invitation to shake the strangle hold of this conception on theory of motivation:

At any rate, further persistence of the hunger-pain-sex approach (or still more, in the attempt to reduce everything to pain alone) is open to the strong suspicion that the writer is refusing even to consider the evidence, for this line of theorizing has long been contradicted by the facts and its explanatory value has decreased, instead of increased, with research of recent years. We must assume that such biological hedonism has seen its day (57, p. 459).

Certainly an adequate recognition of the difficulties confronting the drive theory of motivation on its own home ground in animal research (and, by implication, similar ideas extrapolated to the human level) is now more than sufficient to justify serious consideration of alternative conceptions of human motivation, particularly when they are clearly suggested by experimental evidence on human Ss.

A conception of achievement motivation and anxiety about failure.—In that variant of "expectancy-value" theory which is specifically addressed to the problem of achievement striving and anxiety about failure [Atkinson (6), (7, Chap. 22)], it is assumed that there is a disposition (or capacity) to derive satisfaction from successful exercise of skill which is arbitrarily called "the achievement motive" and an independent disposition (or capacity) to experience shame, humiliation, and embarrassment as a concomitant of failure which is arbitrarily called "the motive to avoid failure." Both of these dispositions are activated when the cues of a performance situation (by virtue of prior learning experience) arouse in the person cognitive expectancies that the outcome of his performance will be evaluated against standards of excellence which define success and failure. The momentary strength of motivation to achieve (i.e., to approach the task with interest and the intent of doing well) is a function of the strength of achievement motive, the strength of expectancy that success will be attained as a consequence of performance, and the incentive value of accomplishment (i.e., of successful performance)

at the particular task. The momentary strength of motivation to avoid failure (i.e., the arousal of anxiety about failure and the tendency to avoid or withdraw from the threatening situation) is a function of the strength of the avoidant motive, the strength of expectancy that the consequence of performing the task will be failure, and the negative incentive value (i.e., the threat) of failing at the particular task that has been presented. These two opposing tendencies to approach and to withdraw are inherent in any activity when the behaving individual expects that his performance will be evaluated and that the outcome will be either success (a personal accomplishment) or failure (a sense of incompetence). In other words, the promise (or challenge) of achievement and the threat of failure are inextricably linked.

This theoretical scheme gives the disposition (or motive) to approach success (to be inferred from TAT n Achievement) and the disposition (or motive) to avoid failure (to be inferred from TAQ and, possibly, MAS under certain conditions) equivalent conceptual status. Both motives are tentatively considered relatively stable, early-acquired characteristics of basic personality structure. They are further conceived as directional dispositions which selectively influence response tendencies that have been associated in the past with the to-be-approached goal (success) or the to-be-avoided threat (failure). The effect of momentary environmental stimulation in achievement-related situations is conceived in terms of, first, the strength of expectancies aroused in the person that particular actions will lead to (or bring about) success or failure and, second, the incentive values of these incompatible outcomes.

Several important assumptions are made in the application to the sphere of achievement striving of a "motive \times expectancy \times incentive" conception of motivation. Following earlier proposals of Escalona and Festinger [see (84)], it is assumed that, when the type of activity or task is held constant, the most critical situational factor influencing the arousal of either motivation to achieve or anxiety about failure is the difficulty of the task as it appears to S. The incentive value of success or achievement (I_s) is assumed to be a linear function of the difficulty of the task performed. In other words, as a consequence of prior learning experience, there is greater pride in accomplishment of a difficult feat than of a very simple task. The negative incentive value of failure (I_f) is assumed to have just the opposite relationship to the difficulty of the task. That is, shame and embarrassment are normally more distressing when one has failed at a simple task than at one which appeared extremely difficult in the first place. Conceptually, the "apparent difficulty" of the task to the person corresponds to the relative strength of expectancies that performance of task-relevant responses will lead to success or to failure. Probability numbers from 0 to 1.00 represent the strength of the expectancies that some response will lead to the goal (success) or to the threat (failure), and the incentive values of success and of failure are then inferred from the measure of the strength of expectancy of success (P_s). The incentive value of success (I_s) is assumed equal to $1 - P_s$; the incentive value of failure (I_f) is assumed

equal to $-P_a$. Given any particular task, the strength of motivation to achieve success (i.e., to approach) through performance of the task is a function of $M_a \times P_a \times I_a$; the strength of motivation to avoid failure (through non-performance of the task) is a function of $M_{af} \times P_f \times -I_f$. The resultant motivation equals approach plus avoidance. The major implications of this theoretical scheme, which should apply to any situation in which the person thinks that the adequacy of his performance will be evaluated against standards defining personal success and failure, are:

(a) Motivation to achieve (approach) is most strongly aroused by tasks of intermediate difficulty, where $P_a = .50$, for here the product of $P_a \times I_a$ (the situational contribution to achievement motivation) reaches its maximal value. Motivation to achieve decreases in strength as P_a becomes either higher or lower. When the achievement motive is strong so that the resultant of approach-avoidance conflict in achievement activities is positive, the person should select (or prefer) tasks of intermediate risk. He should also show greater interest and effort (as measured by performance level) when P_a is near .50 than when the task appears either very simple (high P_a) or extremely difficult (low P_a). When the level of difficulty of the task is held constant, the behavioral manifestations of motivation to achieve success (performance level and persistence) should be greater the stronger the achievement motive within the individual. This is a consequence of the multiplicative function relating M_a (the personality variable) and $P_a \times I_a$ (the situational variables) which together influence the momentary strength of achievement motivation.

(b) Anxiety about failure (i.e., avoidant motivation) should also be most strongly aroused by tasks of intermediate difficulty, where $P_f = .50$, for here the product of $P_f \times -I_f$ is also at a maximum. Avoidant motivation also falls off in strength as P_f becomes either higher or lower. Consequently, when the motive to avoid failure is strong so that the resultant motivation in competitive achievement activities is negative or avoidant, there should be greater anxiety about tasks of intermediate difficulty and hence strong avoidance of intermediate risk. The anxious individual should select either very easy or very difficult tasks when compelled (as he must be) by extrinsic factors to make a choice. When the level of task difficulty is held constant (and the anxious person is constrained by extrinsic factors from leaving the task), the stronger the motive to avoid failure (i.e., the stronger the disposition to be anxious when there is a threat of failure) the stronger the anxiety aroused by the task, and the greater the tendency to make task-irrelevant avoidant responses the greater will be the decrement in performance of the task-relevant responses and the weaker the tendency to persistence in the face of obstacles.

The crucial issue in testing any of these hypotheses is the assumption to be made concerning the relative strengths of the two motives within the individual. Evidence already cited concerning the lack of relationship between scores on tests of anxiety disposition and thematic apperceptive measures of

n Achievement obtained under a standard neutral test condition suggests that the two dispositions are normally independent, at least within the college population. If so, then when Ss are classified as high and low in terms of TAT n Achievement, it is reasonable to assume that M_h is likely to be stronger than M_{af} in the high group, but the unmeasured M_{af} is likely to be relatively stronger in the low group. Similarly, individuals classified as high or low in terms of scores from either TAQ or MAS can be thought to differ in the relative strengths of the two motivating dispositions. The high-anxiety groups contain Ss in whom M_{af} is strong in relation to the unmeasured M_h ; the low-anxiety groups contain Ss in whom M_{af} is weak in relation to the unmeasured M_h .

Recent studies have shown that Ss high in n Achievement do show greater preference for intermediate risk than Ss low in n Achievement. McClelland (101), using a graphic expression index of achievement motive, validated by Aronson (4) against TAT n Achievement in college students, first found the differential preference for intermediate risk in a ring-toss game and other simple tasks with children as young as five years. Experiments in the Michigan laboratory (5, 8), using male college Ss and either the TAT method or the French Test of Insight to assess n Achievement, have consistently reproduced the result in various tasks (ring toss, shuffleboard, choice of puzzles). Some experiments have employed the TAQ to assess what is here conceived as strength of motive to avoid failure. The results sustain the hypothesis that persons who are high in test anxiety less frequently prefer tasks of intermediate difficulty than Ss who are low in test anxiety. Atkinson & Litwin (8) studied three dependent behavioral variables on the same Ss—choice of distance in a competitive ring-toss game (selection), time spent working at a final exam (persistence), and grade on the final exam (performance level)—and assessed both strength of n Achievement and test anxiety. Achievement motive was positively related and test anxiety negatively related, as predicted, to preference for intermediate risk, performance level, and persistence. French & Thomas (50) had previously shown a very clearcut positive relationship between n Achievement and persistence (time spent) in the solution of a very complicated problem by a group of Air Force personnel. Mahone (94) has found that strong achievement motive (and weak anxiety) in male college Ss is associated with vocational aspiration which is judged realistic by clinicians and which requires ability similar to the S's ability; strong anxiety (and weak achievement motive) is associated with aspiration that is judged unrealistic by clinicians and that demands either much greater or less ability than S has. Atkinson (7, Chap. 20) has found that female college Ss work harder for monetary prizes when they are given an even chance of winning than when given either high probability (3/4) or low probability (1/20) of winning. In exploratory studies, Atkinson (6) and Scodel (134) have reported a positive relationship between n Achievement and preference for intermediate risks in betting. But Littig (90), in a more thorough analysis of achievement-related motivation and probability prefer-

ences in a game of chance, shows that Ss who are highly motivated to achieve discriminate between activities which require skillful performance (where winning is a personal accomplishment) and games of chance (where it is not). Kausler & Trapp (68), in a study that is questionable because the results for male and female Ss are lumped and no scoring reliability is reported, nevertheless report results which confirm earlier findings (103, pp. 224 to 248) and an hypothesis (6, p. 367) concerning the effect of *n* Achievement on initial expectancy of success. When Ss were "informed that E was interested in seeing how well they could estimate their performance from trial to trial" (68, p. 576) on a digit-symbol test, the high *n*-Achievement group (French Test of Insight) had higher average D-scores (i.e., estimate minus past performance) than the low *n*-Achievement group on early trials, but the difference vanished with increased practice. This result might be mistakenly taken as a disaffirmation of the hypothesis that Ss high in *n* Achievement should have an intermediate level of aspiration if, as is common in literature on level of aspiration, one fails to distinguish between responses which indicate expectancy of success (e.g., "What score do you expect to make?") and responses, like the free choice of the task to be performed, which indicate what goal the S is actually trying to make.

The theoretical model clearly implies that when the achievement-relatedness of the performance situation is made more salient by experimental instructions than it is in the usual neutral, relaxed, or nonachievement-related control-condition, two different motives are simultaneously aroused. One of them, *n* Achievement, produces positive interest in the task (an approach tendency) which should enhance performance relative to the control condition; the other (presumably what is measured by anxiety scales) produces anxiety and avoidant tendencies which should interfere with performance of the task and produce a decrement relative to the control condition.

The unexplained findings in studies which have measured only *n* Achievement have been the decrements in performance of Ss having low *n*-Achievement scores under achievement-orienting (or threatening) conditions. Moulton *et al.* (113) report that Ss low in *n* Achievement show significantly lower perceptual sensitivity to tachistoscopically-presented achievement-related words (i.e., perceptual defense) when threshold determination is immediately preceded by a motive-arousing achievement test than when the prerecognition period is neutral. And, turning again to the anxiety studies, more important than the issue of whether drive or drive stimulus is the ultimate source of decrement among highly anxious Ss, the topic which continues to receive attention in current papers [Taylor (147)], is the question of why the performance of Ss who are low in anxiety should be enhanced under increased "stress" or "threat" or when performing relatively complex rather than simple tasks. The so-called complexity of the task can be considered one of the factors affecting its "apparent" difficulty (i.e., P_s and P_t) to the S. The tendency of Ss who are low in anxiety to perform relatively better under conditions of increased complexity of task or increased situa-

tional "threat" than when faced with a simpler task or more neutral task conditions is explained in the scheme reviewed here. The trend in their performance is attributed to differential arousal of unmeasured positive motivation to achieve.

Studies of manifest anxiety.—Taylor (147) discusses results which are interpreted as being inconsistent with the theory that competing task-irrelevant (or extratask) responses are more strongly aroused by stress conditions in highly anxious Ss than in less anxious Ss. She argues against the idea that more complex tasks are considered by Ss to be more difficult and that these, therefore, arouse more anxiety than less complex or easy tasks. However, Spielberger, Goodstein & Dahlstrom (145) again report an interaction between MAS and task difficulty; the least anxious Ss perform better on more difficult tasks. Nicholson (115), also using MAS, presents results like those of Katchmar, Ross & Andrews (67), which show that performance level of anxious Ss shows a decrement from task- to ego-orienting conditions, but that performance level of nonanxious Ss is enhanced by ego orientation. To explain why the high-anxiety group performs somewhat better than the low group under task orientation, it is suggested that task orientation may not succeed completely in keeping anxiety from being aroused in high-scoring Ss, or "high scorers have a higher need achievement than low scorers" (115, p. 315). This suggestion runs completely contrary to the facts in studies of the relationship between anxiety and *n Achievement*.

Writers primarily concerned with anxiety drive are constrained by their theory from considering the possibility that there might be other "extrinsic" motives for performance in situations designed not to arouse anxiety about failure. But French and others [see (7, Part III)] have shown how *n Affiliation* can influence "achievement" performance under relaxed, nonachievement-oriented conditions. The plausibility of the suggestion is increased since deRivera (33) has shown that *n Affiliation* is higher among anxious Ss.

Nicholson also reports behavioral observations of Ss working at a difficult task under ego orientation; these appear congruent with the conception of anxiety as motivation to avoid the task: "Some Ss gave up and made a minimal effort to learn" (115, p. 315). The assumption that anxious Ss "leave the field" under strong threat of failure is also advanced by Raphelson & Moulton (123) to explain the pattern of relationships among galvanic skin reaction (GSR), test anxiety, and TAT achievement imagery under various conditions of threat of failure.

Romanow (125) finds that highly anxious Ss perform more poorly than less anxious Ss at a complex task in one experiment; but in another, using unclassified volunteers as Ss, the least involved of three ego-involvement conditions showed the lowest level. Romanow offers the *post hoc* suggestion that "low involvement gives rise to careless inattentive attitude resulting in increased overt errors" (125, p. 172). This is probably correct. Volunteers, distinctive on a number of personality variables (51, 99), are likely to be

higher in *n* Achievement (100, p. 18), lower in anxiety, and less prone to take the task seriously under neutral (or low involvement) than under achievement-oriented (high involvement) conditions. Romanow's interpretation could easily be extended to explain the normal decrement in performance of highly anxious Ss under threatening conditions when inattention to the details of the task could then be viewed as symptomatic of avoidance, i.e., leaving the field.

Besch (12), Chiles (28), Fager & Knopf (42), and Buss & Gerjuoy (22) report results that appear inconsistent with hypotheses about anxiety drive. Spielberger (144) reports negative correlations between MAS and intelligence test scores in men, but inconsistent results in women. Kausler & Trapp (70) discuss methodological difficulties in experiments which attempt to establish the construct validity of drive scales. Lipsitt (89) discusses how self-disparagement might be learned in the context of acquiring anxiety as a consequence of punishment. Taylor & Rechtschaffen (148) show a substantial negative relationship between reversed alphabet printing and MAS with no evidence that reactive inhibition generated in massed practice is related to MAS. Meyer & Noble (107) show that when a dynamometer is squeezed while learning a verbal maze, the high MAS group shows a decrement and the low group an increment in performance.

Studies of test anxiety.—Sarason *et al.* (130) report obvious sex differences in achievement-related classroom behavior, a problem which has arisen also in thematic apperceptive studies of *n* Achievement. Behaviors which are symptomatic of a need to achieve (i.e., attention to tasks, volunteering, pleasure in good work) were equally frequent in anxious and nonanxious boys; but girls having high-anxiety scores were more frequently described this way than girls having low scores.

Focusing on Rorschach performance, Sarason *et al.* (131) again emphasize the different psychological significance of anxiety scores in boys and girls, reporting that the highly anxious boys "present a rather clear behavioral picture of indecision and dependence." Waite *et al.* (155) find that boys who are low in anxiety perform better at a learning task than boys who are high in anxiety, indicating that the trend observed in college Ss develops early in life. Doris (35) finds test anxiety in children related positively to attitudes of self-blame and TAT expression of self-blame. In a study of pilot trainees, deRivera (33) finds anxiety manifested in flying correlated .59 with a modified form of The Anxiety Questionnaire, .49 with *n* Affiliation assessed using the French sentence technique, -.48 with ratings of the instructor's patience, and with other special measures. The possibility that *n* Affiliation measures sensitivity to criticism is proposed. Mandler & Cowen (95) present a Test Anxiety Questionnaire for use with high school students. Sperber (143) presents TAQ scoring norms for a large heterogeneous male population (Air Force personnel) and reports the frequently found positive correlation between MAS and TAQ (.20 to .35).

Other studies of n Achievement and n Affiliation.—Samelson (129) examines the interactive effects of *n Achievement* and *n Affiliation* on conformity. French (49) focuses upon the interaction between kind of motive within *S* and kind of incentive (or goal satisfaction) offered in the performance situation [also of central interest in the work of Vogel, Raymond & Lazarus (154) on stress] to show how the kind of feedback *Ss* are given concerning their performance defines the kind of incentive. Comparable high performances were observed in two motivation groups when the expected goals to be attained in the situation were congruent with the strongest motivational dispositions of the *Ss*. Groesbeck (55) presents a summary of personality correlates of *Ss* simultaneously classified by strength of achievement and affiliation motives. Aronson (4) presents evidence of the validity of a nonverbal, graphic expression measure of *n Achievement*, which made use of doodling. The test was used by McClelland (102), along with content analysis of literary documents of Ancient Greece, to show how an index of the rise and fall of Greek civilization relates to changes in both achievement imagery in literature and changes in the frequency of graphic-expressive symptoms of *n Achievement* in designs on pottery. Results of this substantive study (conducted with David Berlew) provide the context for discussion of problems arising in the more general use of psychological methods of content analysis for assessment of motivation in studies of society. Winterbottom (157) found that boys high in *n Achievement* made fewer requests for help, refused help when offered, and refused a rest period—all symptoms of positive interest and persistence. Considered in relation to results of Sarason *et al.* in studies of test anxiety in children, Winterbottom's findings imply that *n Achievement* and test anxiety are not likely to be positively correlated. Boys high in *n Achievement* are described by teachers as manifesting stronger desire to perform well, to be more popular and more independent, and as deriving more pleasure from success. The latter suggests the conception of achievement motive as a capacity for pleasure and pride in accomplishment and, correspondingly, the conception of the motive to avoid failure as a capacity for displeasure and shame over failure. Baldwin & Levin (9, 80) define pride "as an emotional state resulting from public exposure of good qualities or good intentions" and shame as "an emotional state that occurs when one's defects, poor abilities, or bad intentions are made public" (9, p. 363). Their findings suggest that "when children anticipate feelings of pride, they will choose to make themselves and their competencies visible. . . . Conversely, the anticipation of shame disposes them to conceal themselves and their inadequacies" (80, p. 380).

Knapp (74, 75) assumes that *Ss* with strong *n Achievement* are basically committed to an "ego posture" characterized by a desire to manipulate the environment. Hence, they should prefer somber background colors like blue rather than intrusive colors like red which provide distracting stimuli. They should, in addition, have an "acute awareness of time as a medium in which achievement might be realized." Knapp has shown (74) that preference for

blue Scotch tartans is positively related to *n* Achievement and preference for red tartans is negatively related to *n* Achievement in male college Ss. The relationship is substantiated in McClelland's (101) study of young children. Knapp & Garbutt (75) have also shown that college men who are high in *n* Achievement, when asked to choose the metaphor that most appropriately captures their image of time, select images which involve swift movement like "a dashing waterfall" or "a galloping horseman." In the Knapp-Garbutt conception of the "ego strategy" manifested in achievement motivation, time is considered a standard against which the active individual must compete. However, other studies (92, 133) suggest that a sense of fleeting time may be more a general correlate of strong motivation for any goal than specifically a correlate of strong achievement motivation.

Stress in achievement settings.—Vogel, Raymond & Lazarus (154) find an interaction between the predominant kind of motivation and kind of stressor in determination of "stress" reaction. Achievement-oriented Ss show greater autonomic reactivity when exposed to achievement-oriented conditions than when exposed to affiliation-oriented conditions; and affiliation-oriented Ss showed the reverse. Stress tends to facilitate performance of a perceptual-motor task, but impairs performance of a conceptual task. The general conception of the Lazarus group, that the stressor (i.e., the operations employed by E to induce stress) must be relevant to the predominant motivation of S to produce stress (i.e., the state of the person indicated by autonomic reactivity) is similar to the conception of motivation as being jointly determined by motives within the person and situationally-defined expectancies. These writers, however, eschew the use of "fantasy" measures of motivation in the light of their conviction, based on interpretations of their own earlier findings (78), that thematic apperceptive measures do not yield "pure" measures of motivation. Examination of these earlier studies in this series (78, 153) reveals that it is impossible to evaluate the merit of some of their arguments because the studies do not report coefficients of scoring validity or reliability, or describe adequately the conditions under which the projective measures were administered as well as other important procedural detail.

PROBLEMS IN ASSESSMENT OF MOTIVATION

The meaning of "motivation".—Since 1953, *The Nebraska Symposium on Motivation*, under the editorship of Jones (66), has fed the timely debate on the meaning of motivation in psychological theory. Several new volumes take up the debate. Lindzey (86) has organized the opinions of some notable contributors (Allport, Cattell, Festinger, Janis, Kelly, Klein, Murray, and Schafer) concerning conceptions and techniques in *Assessment of Human Motives*. Peters, in *The Concept of Motivation* (120), has taken to task both drive theory and the modern regression into hedonism. In an exhaustive historical summary of the varied meanings assigned to motivational concepts, Littman (91) shows how meaningless it is to conceive of some variables

as activators of behavior and other variables as more passive or inert dispositions. He points out that if we take Hull's famous equation, $sEr = sHr \times D$, and give sHr a value of zero, there is no "activation" of behavior. Similarly, if D is held constant, the resultant behavior depends upon the strength of sHr .

When the dust settles on the many word-worrying discussions that mark current debate about motivation, which, in terms of sheer volume, sadly far outrun sustained empirical efforts, this reviewer would turn to the general position represented by Festinger in the Lindzey volume as most sound:

... one cannot choose among alternative hypothetical human needs apart from the theory in which these constructs are embedded. And if a postulated human need is not part of a theory or hypothesis, one cannot evaluate it at all. Indeed, if it is not a part of a theory it is not performing any explanatory function and, apart from perhaps adding a gratifying technical ring to our language, it is useless (46, pp. 66 to 67).

But elsewhere this reviewer (7, pp. 1 to 6) has just as firmly disagreed with another viewpoint expressed by Festinger when he asserts:

I do not think it will be maximally fruitful in the long run to begin by developing tests to give measures of the strength of some hypothesized human need, and then to attempt to discover how this need operates. I believe strongly that it is better to proceed in the reverse order. After one has demonstrated the validity and usefulness of some hypothesized need is the time to start measuring individual variation. One knows much more clearly what one is trying to measure, why one is trying to measure it, and to what the individual measure should relate (46, p. 86).

It is time we declared a plague on both these conventional approaches!—that of the traditional experimentalist who seeks for lawfulness through manipulations of environmental factors, leaving half his antecedent condition (the personality) undefined and never getting to the problem of effects of individual differences; and that of the traditional mental tester, so preoccupied with the psychometric properties of his assessment instruments and with static analysis of correlations among standard test scores that he doesn't see the vital necessity of experimental analysis and theory construction. We know enough to know that interactions between personality dispositions (half of our antecedent condition) and contemporaneous environmental factors (the other half) are complex and that the only way to overcome the impasse between what Cronbach (31) has called "the two disciplines of scientific psychology" is to initiate research with simultaneous interests in both the development of techniques for assessment of individual differences in what we must at the outset guess to be relevant dispositions, and in creating meaningful and lifelike variations in what we must at the outset guess to be relevant environmental factors.

Thematic apperception.—Haber & Alpert (56) report results of the most carefully designed effort to assess retest equivalent form reliability of TAT n-Achievement scores. Except for the relatively small N , their work can serve as a model for future efforts of this sort. One group of male college Ss

($N = 26$) tested under controlled relaxed conditions with a three-week interval yielded a retest correlation of .54 on carefully pretested equivalent six-picture forms. The estimate of reliability of a six-picture test having all strongly cued pictures is .74 and having all weakly cued pictures (i.e., to which only 25 per cent to 50 per cent of Ss respond) is .54. There is, in other words, a substantial drop in reliability when the stimulus is weakly structured. Haber & Alpert tested another group ($N = 54$), first under relaxed conditions, and several weeks later under achievement-oriented test-conditions. The correlation on equivalent forms dropped to .45 (still, however, $p < .05$). Haber & Alpert argue for research aimed at assessment of how Ss differ in reaction to specific motivating cues. Efforts of this kind have also been initiated by Jacobs (62), Birney (14), Lesser (79), and Murstein (114), following Rotter's (128) lead.

Birney (15) reports correlations ranging from .03 to .56 (average about .30) between four TAT n-Achievement measures obtained from male college Ss over a two-year period. However, this study is weakened by a shrinkage in N from 60 originally invited to 26 who appear for the last test. In addition, the sets of pictures are weakly cued. Himelstein, Eschenbach & Carp (60) report no relationship between n-Achievement scores obtained from four TAT pictures and from Form I (weakly cued) of the French Test of Insight (48) administered as part of a two-day testing program. The absence of correlation between the two tests would have important implications were it not for several common methodological defects of which the writers seem unaware. Interjudge scoring reliability for n Achievement is very low (not high, as they presume), only .70 to .71, in relation to other published interjudge reliabilities which, as summarized by Feld & Smith (44), are found to range from .66 to .95 with a median of .89. Thus, error variance attributable to scoring is increased by about 30 per cent over what can be attained with greater attention to procedural detail. In addition, no description is given regarding the conditions of administration or the serial location of the two tests in the larger two-day testing program, a cardinal deficiency in light of all that has been published concerning the sensitivity to situational influences of projective techniques of this sort.

A "fact" reported in a study having obvious methodological weaknesses is devoid of meaning. The number of "hit and run" research efforts with misleading implications for the general reader could be greatly reduced if journal editors would insist upon (and also allow) more evidence that writers were fully aware of the importance of methodological detail. Result-oriented editors, under the pressure of limited space, too frequently forget that a scientific fact is a relationship between antecedent conditions (who-when-where?) that should be as meticulously described in the procedure section as the behavioral consequence (did what?) is described in the section devoted to results. Publication of a research handbook (7) containing detailed scoring manuals for n Achievement, n Affiliation (58) and n Power (152), extensive pretested practice materials for thematic content analysis (139), and a va-

riety of illustrative studies may help to alleviate the acute procedural problem that has arisen in connection with the use of thematic apperceptive measures.

Lindzey (87) has offered a classification of projective techniques to provide a starting point for thorough analysis of their similarities and differences as assessment methods, and has discussed the strategy of TAT research (85) in a volume honoring Henry A. Murray (73). Lindzey & Kalmins (88) provide evidence favoring the assumption that S identifies more clearly with the "hero" of TAT stories than with other characters. Purcell (121) presents a sound critique of those who censure projective methodology. He highlights the naïveté which characterizes most research, calling for more sophisticated conceptualization of the tests themselves and the criterion performance situations, particularly the action of avoidance tendencies which might conflict with the expression of motivation in thematic content or with its overt expression in performance after appearing in thematic content. He takes issue with the hypothesis that fantasy is a substitute for overt striving (78), suggesting instead that fantasy responses may be considered a preparatory stimulus for action rather than a drive-reducing substitute. Reitman & Atkinson (124) review methodological issues in the use of thematic apperception to assess motivation, calling particular attention to serial position effects and results which show that the validity of motivation indicators may be limited to the first four to six pictures.

Self-report tests of anxiety.—Mandler, Mandler & Uviller (97) have examined the relationship between electrical recordings of physiological symptoms (heartbeat, psychogalvanic response, respiration, face temperature, and blood volume) and Ss' reported perceptions of this activity. An Autonomic Perception Questionnaire (APQ), consisting of items covering various types of bodily reactions, produces total scores which correlate in the .50s with MAS when the focus of items is "anxiety" and in the .30s when the focus of items is the positive emotion, "pleasure." Interview reports concerning perceptions of autonomic changes obtained immediately after an achievement-oriented test are significantly related to APQ scores obtained earlier. Ss (extreme groups) classified as high perceivers on both APQ and post-session interviews are found to show significantly greater autonomic reactivity under stressful performance than those classified as low perceivers. High perceivers were found to overestimate, and the low perceivers to underestimate, the magnitude of their autonomic responses as electrically recorded. In a follow-up study dealing with an unselected population instead of extreme groups, Mandler & Kremen (96) found lower positive correlations between the APQ measure and the MAS and Body Perception Scale (BPS) from the Minnesota Multiphasic Personality Inventory (MMPI). Neither of the MMPI scales was significantly related to electrical recordings of total autonomic activity, again taken during achievement-oriented performance, but both APQ scores and post-performance interview perceptions of autonomic reaction did relate positively to the composite physiological index.

However, all three verbal report scales, the MAS, BPS, and APQ, correlated $-.22$ to $-.31$ with performance on a difficult vocabulary test (one of three tasks used during the stress session), but the electrical recording measures of autonomic reactivity did not. Mandler & Kremen suggest that interference with intellectual performance appears to be more a function of perceived than actually present autonomic discharge. What is not sufficiently clarified is the extent to which results concerning tendency to overperceive and underperceive autonomic reactions might be explained by assuming that both electrical recordings and self-reports are fallible measures of the actual autonomic reaction, following the logic of Eriksen's (39) analysis of subception data.

The problem of ad hoc methods.—Deserving of comment is the decision of Vogel, Raymond & Lazarus (154) to fall back on a composite index of behavioral ratings and other measures of characteristic behavior of Ss over time, to define kind of predominant motivation (achievement-oriented or affiliation-oriented). This they did in their most recent study of stress. This type of measure overlooks the distinction between underlying motive (genotype) and actions and accomplishments (phenotypes) which are often overdetermined, i.e., influenced by many different kinds of motives and conditions. Pepinsky, Hemphill & Shevitz (119) provide another illustration of the same general problem. They begin with conceptual definitions of n Achievement and n Affiliation taken directly from experimental studies using thematic apperceptive measures which are cited as references. Then, however, the conception of strength of motive is extended and a novel and *ad hoc* method of assessment is introduced. The hypotheses concerning effect of individual differences in motivation on leadership are not confirmed. The writers conclude: "Under condition R (rejection) individuals with high need Achievement did not attempt to lead with greater frequency than individuals with high need Affiliation" (119, p. 53).

The right of every researcher to his own approach to assessment of motivation is certainly inviolate even though the use of an *ad hoc* method means that the substantive findings will stand in isolation from all other findings, so many of which also involve *ad hoc* assessment devices. What, then, is the critical problem? In citing experimental studies in terms of which (in this case) the concepts of achievement motive and affiliation motive were developed through the use of thematic apperceptive indices, the writers (and certainly their readers) implicitly assume that the theoretical conception already advanced and the fund of factual information already available concerning these variables are pertinent. In concluding that n Achievement and n Affiliation are unrelated to leadership, the writers unwittingly encourage superficial and misleading attempts at integration of psychological research in terms of verbal labels rather than in terms of the details of factual evidence. This has become a deplorable obstacle to progress because it produces an endless supply of apparently contradictory experimental findings. The problem, a constant one in many areas of research, is now highlighted when

one considers the growing number of what are claimed by their authors to be more valid, objective, or economical tests of individual differences in strength of achievement motive than the method of thematic content analysis advanced by McClelland *et al.* (103). The persistent effort to find a more simple, general method for assessment of motivation than thematic apperception is to be encouraged. The unfortunate trap, however, into which many researchers have fallen, is that of assuming in advance of experimental analysis that any other kind of test device can be taken as an equivalent of a thematic apperceptive measure just so long as great care is taken to develop items or rating criteria that appear *a priori* to be consistent with the conception of the motive that has been advanced. Bendig (10), Birney [in McClelland (100)], and Melikian (106), for example, report no relationship between apperceptive *n*-Achievement scores and the variable called "*n* Achievement" on the Edwards Personality Preference Schedule.

McClelland (100) reviews various methods that psychologists have employed to assess individual differences in motivation in light of a number of meaningful criteria. He argues that self-descriptive methods and judgments by others are generally reliable response measures but suffer from being "multidetermined"; that is, they are influenced in complex ways by many variables other than the kind of motivational variable that they purport to measure. One factor of notable importance is response set, e.g., the factor of social desirability which Edwards (37) and others (34) are now exhaustively analyzing. McClelland argues that, while the criterion of reliability is harder to satisfy for methods like thematic apperception, which are sensitive to both dispositional and situational factors, the thematic apperception method, when used appropriately, tends to fare better than the others against the only meaningful criterion of validity, "relational fertility." Here McClelland refers to the issue of "construct validity" [see Cronbach & Meehl (32)], already discussed by Taylor (146), Jessor & Hammond (65), and Hill (59) in relation to the Manifest Anxiety Scale. McClelland's view is consistent with the notion that the claim for the validity must ultimately rest on evidence showing that an instrument yields indices of strength of motive, which, given a theory explaining the way motives influence behavior, produces specific predictions which are confirmed by experiment. But he is less willing than others to assume that we already have such a theory of human motivation. Hence, he argues that the most promising evidence of validity is the extent to which a measure begins to produce a meaningful pattern of relationships over a range of human behavior which can serve as a broad empirical basis for theory construction. The most timely contribution of this paper is its conclusion: "... the three methods of measuring human motivation yield essentially uncorrelated results, and it would seem wise for research workers to employ terminology which will communicate immediately which method of measurement they are using" (100, p. 41). However, in comparing measures of identification, Block (16) has found that indirect and time-consuming approaches (semantic differential) do not always yield results that differ

from those obtained with a simple direct method (adjective check list). Atkinson (7, Chap. 42) has discussed how the "motive \times expectancy \times incentive" theory applies to motivation as expressed in thematic content. Issues of reliability and validity are examined within the context of this theoretical scheme.

The fact that attempts to assess the same motivational variable by the different test methods known to psychologists do not yield equivalent indices should be one of the problems of major theoretical interest among test makers. Why isn't it? What are the dynamics of the so-called response sets (19, 34, 77) which have been discovered? Edwards (37) has begun to think in this vein when he argues that his SD scale, which indicates a person's preference for socially desirable alternatives, might be considered an indirect test of the strength of a general motive to be socially acceptable. This seems a promising beginning to giving objective test scores some kind of theoretical meaning.

Factor analysis.—How else can the problem created when the same name is given to uncorrelated test behaviors be resolved? In a review of 13 multivariate analyses comprising 814 variables, Cattell & Scheier (26) have argued for the case of factor analysis to close in on the measurement of anxiety. They found a single factor, U.I. 24, to be well replicated over 13 studies: "This factor's pre-eminent claim to the title 'anxiety' resides in the manifest content of its variables, conforming to the common core of semantically sanctioned use of the term 'anxiety' in such variables as tension, emotionality, and self-rated presence of clinically-accepted symptoms of anxiety" (26, p. 385). Other primary characteristics of anxiety were found to be: a self-depreciative lack of confidence in oneself, a willingness to confess faults and troubles [see also Edwards' report that social desirability correlates $-.60$ to $-.84$ with manifest anxiety scores (37, p. 33)], and irritability, which apparently indicates frustration without overt aggression. In his book, *Personality and Motivation, Structure and Measurement* (24) and in a shorter paper (25), Cattell reports the results of his broader effort during the past decade to identify the dimensions of strength of motivation and to identify a limited number of independent kinds of motivation. In brief, Cattell and his co-workers exhaustively reviewed the literature to discover what sorts of behavioral phenomena had been attributed to the influence of "motivation." A total of 60 different behavioral symptoms that one or another researcher had attributed to motivation were identified and short tests of these phenomena were developed. Then, holding the content of attitudes constant [attitude defined as: "In these circumstances I want so much to do this with that" (24, p. 444)], Cattell administered these various tests of "strength of motivation," subjecting the results to factor analysis. The factor analysis yielded four motivational component factors, i.e., factors contributing to the strength of any particular motive. They were: Alpha—the id component in interests; Beta—the realized ego; Gamma—ideal self or superego; Delta—unconscious physiological interests; Epsilon—repressed complexes. Cattell

concludes that he has "certainly demonstrated that the intensity of interest in a course of attitude action cannot be called a single intensity" (24, p. 464). Another factor analysis of different kinds of motives yields a list of primary "ergs," i.e., sources of the energy expended by persons in proceeding toward particular biological goals. The list is reminiscent of that of McDougall.

The idea of factor analysis has strong appeal in these days of terminological confusion, but the argument between factor analyst and experimentalist deserves more extensive debate so that the most useful role of factor analysis can finally be clarified and fully appreciated. In addition to questions that need to be raised concerning the adequacy of short tests of important phenomena, the extent to which short-term and long-term serial position-effects influence the matrix of correlations, the issue regarding the mathematical model which provides the foundation for factor analysis, and the issue of inadequate appreciation of the role of momentary environmental factors, there are one or two more general points that need to be considered. Factor analytic methodology, as employed by Cattell at least, is an extremely conservative methodology. It begins, as in this instance, with a review of the work of others who have analyzed the problems of motivation and given the concept some meaning by identifying certain behavioral phenomena which are presumably to be viewed as effects of "motivation." In this sense, then, the approach is conservative: it contributes no new idea of its own concerning the nature of motivation or the details of the motivational process. And then, as might have been anticipated, when a number of independent dimensions issue forth from the statistical operations, the factor analyst is again conservative. These dimensions are given names which suggest surplus meanings drawn from the work of others who have tried in separate domains of research to clarify the theoretical conception of the motivation process. This writer finds little clarification of the problem of motivation in confronting verbal labels corresponding to the tripartite structural division of personality offered by psychoanalytic theory—id, ego, superego—in light of the great effort in the field of experimental personality to articulate more clearly and to conceptualize more rigorously the processes that were at best alluded to vaguely in some of the initial psychoanalytic writings. The major criticisms of Cattell's recent work are that, in the effort to be exhaustive and definitive, he has been unselective in his choice of what to feed into the factor analysis, and he hasn't helped at all in his guesses as to what the factors mean. If everything in the literature called motivation is to be subjected to factor analysis, then it seems the most we can expect from time to time is a periodic report of the extent to which there is or is not consensus in the use of terms. We know without factor analysis that presently there is not. The consensus will come about when one or another theoretical conception of motivation begins to prove itself useful in organizing the details of experimental results in particular substantive domains. When some good theories have been developed, and when the issue is clearly the construct validity of particular tests administered under specified conditions, factor analysis can play a use-

ful role in sharpening conceptual distinctions, as, in fact, it has begun to in the case of tests of anxiety.

COGNITIVE PROCESS

Regulative processes.—A number of writers (21, 71, 78) are critics of the traditional conception of motivation which separates, as Klein (71) has put it, the push or impelling quality of a "drive" from the cognitive control structures which guide the constant interplay between internal demands (intentions) and external objects and events. Klein has stressed the importance of cognitive attitudes (viz., scanning, leveling, constricted control) and more general cognitive styles which characterize individuals as a consequence of their characteristic cognitive attitude. These cognitive control structures are conceived as the individual's typical strategies in perceiving, remembering, and thinking. They refer not so much to what goals the person is trying to attain as to how—his ways and means—he goes about it.

A study of Adelson & Redmond (1) illustrates this general theoretical orientation. Viewing differences in ego orientation assumed to be associated with fixation in the late (retentive) as contrasted with the early (expulsive) anal phase, these writers find support for their hypothesis that, among retentives, the heightened attention to external stimuli, permitted by the use of isolation as defense and the hypercathection of words, produces a peculiar efficiency in apprehension of verbal stimuli; while, among expulsives, the less efficient mode of handling impulses and affects allows for momentary disturbances of attention and concentration. The findings concern verbal reproductions of innocuous and disturbing material among college women classified as retentive or expulsive in terms of The Blacky Pictures. Adelson & Redmond seriously consider that observed differences in recall might be attributed to some differential in motivation. But, considering all the evidence, they favor interpreting the result as evidence of variation in cognitive style, i.e., in capacity for attention and concentration during the process of acquisition, which defines a differential capacity for incidental learning.

Lazarus *et al.* (78) argue that cognitive regulative processes may be a potent determinant of the fantasy responses used by McClelland *et al.* to assess strength of different human motives.

Cognitive dissonance.—Festinger's (45, 46) theory of cognitive dissonance, focusing (among other things) on cognitive consequences of conflict-filled decisions, helps to overcome an imbalance in the current literature on motivation and mechanisms of defense which concentrates so heavily on the antecedents of conflict and decision. Festinger conceives of cognitive dissonance as a motivating state. "Two cognitions are dissonant with each other if, considering these two cognitions alone, the obverse of one follows from the other" (46, p. 69). Cognitive dissonance gives rise to activity oriented towards reducing or eliminating the dissonance. If a person is forced to make a statement contrary to his opinion, there is dissonance created by the knowledge that he has said "not X" and he believes "X." The dissonance is less-

ened as the number and importance of pressures which induced him to behave contrary to opinion are increased. Consequently, a change of opinion, which is one way of reducing dissonance, should be more apparent when the pressure for making the statement contrary to opinion is just sufficient (i.e., relatively small) than when it is much more than sufficient (i.e., relatively large). Festinger & Carlsmith (47) find that when Ss are induced by offer of monetary reward to report falsely to a fellow student that an obviously dull and boring task is indeed very interesting and enjoyable, evidence of a change in opinion is significant when the reward is only one dollar, but not when the reward is 20 dollars. Mills (111) created differential motivation to cheat in a contest by offering differential rewards for winning. The main hypothesis derived from Festinger's theory was confirmed: Ss who decide not to cheat when tempted will become more severe in their attitudes towards cheating while Ss who cheat will become more lenient.

Promising to be a topic of considerable importance in the immediate future is the clarification of the relationship between conceptions of cognitive regulative processes, the theory of dissonance reduction, and psychoanalytically-oriented theories of conflict and defense mechanism as advanced, for example, by Miller & Swanson (108). The authors elaborate these theories fully in their forthcoming book, *Inner Conflict and Defense* (109).

Unconscious process.—Eriksen (39) has provided a critical review of experimental data relevant to the concept of unconscious process. He considers thoroughly the definitional problems and is incisive in his critical analysis of experiments dealing with discrimination without awareness, perceptual defense, and learning to cues which are suprathreshold but of which S is unaware. A theory is presented to take the place of the concept of the unconscious as an acutely sensitive agency that can enhance or defend against stimulation. The basic idea is that a stimulus arouses a perceptual process which is very fragmentary when the stimulus is very weak. The perceptual process, in turn, activates various response systems, all of which are fallible (i.e., unreliable) measures of the perceptual process when the stimulus is weak; these response systems are not perfectly correlated. As a result, one system, like GSR, may indicate the presence of the stimulus when another system, verbal report, does not. However, the reverse may also be true. Eriksen concludes, after a thorough examination of subception data and subsequent experiments, that there is no unequivocal evidence pointing to a lower threshold of arousal of one response system or another. "In other words, we have no basis for conceiving of the unconscious as a superdiscriminating system" (39, p. 220). Eriksen's conception seems to have direct bearing on a number of problems that have arisen in other research, e.g., in research on the lack of correlation between different measures of motivation and in Mandler's work on perception of autonomic discharge. Eriksen, Kuehe & Sullivan (40) have explored personality correlates of response biases (i.e., learning), established without full verbal awareness by the Ss of the contin-

gent relationship between the E's reinforcing statement ("good") and Ss' responses in a pseudotachistoscopic recognition task.

Klein *et al.* (72) call attention to the need for development of techniques more sensitive than simply studying recognition thresholds to explore how subliminal stimulation may produce unconscious processes which affect conscious thought. They present a realistic or symbolic sexual stimulus for .02 to .035 sec. (assumed to be subliminal) immediately before presenting for .33 sec. an ambiguous human figure as the test stimulus. Impressions of the consciously-seen test stimulus are then examined in relation to the kind of subliminal stimulus (male or female, realistic or symbolic) which has preceded it. Hypotheses are offered concerning the kinds of unconscious processes that are activated to influence the conscious cognition. These writers seem fully conscious and critical of their assumption that Ss did not consciously perceive the critical stimulus. The merit of this work lies in the consideration given methodological issues and the fruitful directions outlined for further work in a discussion that is solidly anchored in a realistic appreciation of the dire need for methodological innovation.

MISCELLANEOUS

Of general interest are reviews of literature concerning expression of hostility [Berkowitz (11)], subliminal stimulation [McConnell, Cutler & McNeil (105)], the present state of psychoanalytic theory [Gill (53)], novel discussions of the process of motivation [Peak (118), Toman (151)], and research at the frontier which fosters the integration of the psychologist's conception of personality and the sociologist's conception of social structure [Douvan & Adelson (36), Levinson (81), Rosen (126)]. See also an examination by Meehl and others of assumptions about man in psychology and theology (30).

LITERATURE CITED

1. Adelson, J., and Redmond, J. Personality differences in the capacity for verbal recall. *J. Abnormal Social Psychol.*, **57**, 244-48 (1958)
2. Allport, G. W. What units shall we employ? In *Assessment of Human Motives*, Chap. 9, 239-58 (Lindzey, G., Ed., Rinehart & Co., Inc., New York, N. Y., 273 pp., 1958)
3. Angelini, A. L. A avabação da motivação humana pelo M.P.A.M. *Separata da Revista de Psicologia Normale e Patologica*, **4**, Nos. 1-2, 3-14 (1958)
4. Aronson, E. The need for achievement as measured by graphic expression. In *Motives in Fantasy, Action, and Society*, Chap. 17, 249-66 (Atkinson, J. W., Ed., D. Van Nostrand Co., Inc., Princeton, N. J., 873 pp., 1958)
5. Atkinson, J. W. Achievement motivation and risk-taking. *Am. Psychologist*, **12**, 382 (1957) (Abstract)
6. Atkinson, J. W. Motivational determinants of risk-taking behavior. *Psychol. Rev.*, **64**, 359-72 (1957)
7. Atkinson, J. W. (Ed.) *Motives in Fantasy, Action, and Society* (D. Van Nostrand Co., Inc., Princeton, N. J., 873 pp., 1958)
8. Atkinson, J. W., and Litwin, G. H. n Achievement and test anxiety: motives to approach and to avoid risky competitive situations. *Am. Psychologist*, **13**, 324-25 (1958) (Abstract)
9. Baldwin, A. L., and Levin, H. Effects of public and private success or failure on children's repetitive motor behavior. *Child Development*, **29**, 363-72 (1958)
10. Bendig, A. W. Manifest anxiety and projective and objective measures of need achievement. *J. Consulting Psychol.*, **21**, 354 (1957)
11. Berkowitz, L. The expression and reduction of hostility. *Psychol. Bull.*, **55**, 257-83 (1958)
12. Besch, N. F. Paired-associates learning as a function of anxiety level and shock. *J. Personality*, **27**, 116-24 (1958)
13. Birch, D., Burnstein, E., and Clark, R. A. Response strength as a function of hours of food deprivation under a controlled maintenance schedule. *J. Comp. Physiol. Psychol.*, **51**, 350-54 (1958)
14. Birney, R. C. Thematic content and cue characteristics of pictures. In *Motives in Fantasy, Action and Society*, Chap. 44, 630-43 (Atkinson, J. W., Ed., D. Van Nostrand Co., Inc., Princeton, N. J., 873 pp., 1958)
15. Birney, R. C. The reliability of the achievement motive. *J. Abnormal Social Psychol.*, **58**, 266 (1959)
16. Block, J. An unprofitable application of the semantic differential. *J. Consulting Psychol.*, **22**, 235-36 (1958)
17. Blum, G. S. Psychoanalytic behavior theory: a conceptual framework for research. (Presented at the 15th Intern. Congr. Psychol., Brussels, Belgium); in David, H. P., and Brengelman, J. C., Eds., *Perspectives in Personality Research* (Basic Books, New York, 1960)
18. Bolles, R. C. The usefulness of the drive concept. In *Nebraska Symposium on Motivation, 1958*, 1-32 (Jones, M. R., Ed., University of Nebraska Press, Lincoln, Neb., 278 pp., 1958)
19. Broen, W. E., Jr., and Wirt, R. D. Varieties of response sets. *J. Consulting Psychol.*, **22**, 237-40 (1958)
20. Bronfenbrenner, U. Personality. In *Annual Review of Psychology*, **4**, 157-82

- (Stone, C. P., and Taylor, D. W., Eds., Annual Reviews, Inc., Stanford, Calif., 485 pp., 1953)
21. Broverman, D. M., and Lazarus, R. S. Individual differences in task performance under conditions of cognitive interference. *J. Personality*, **26**, 94-105 (1958)
 22. Buss, A. H., and Gerjuoy, I. R. Verbal conditioning and anxiety. *J. Abnormal Social Psychol.*, **57**, 249 (1958)
 23. Cartwright, D. Lewinian theory as a contemporary systematic framework. In *Psychology: A Study of a Science. Study I. 2*, 7-91 (Koch, S., Ed., McGraw-Hill Book Co., New York, N. Y., 706 pp., 1959)
 24. Cattell, R. B. *Personality and Motivation, Structure and Measurement*. (World Book Co., Yonkers, N. Y., 948 pp., 1957)
 25. Cattell, R. B. The dynamic calculus: a system of concepts derived from objective motivation measurement. In *Assessment of Human Motives*, Chap. 8, 197-238 (Lindzey, G., Ed., Rinehart & Co., Inc., New York, N. Y., 273 pp., 1958)
 26. Cattell, R. B., and Scheier, I. H. The nature of anxiety: a review of thirteen multivariate analyses comprising 814 variables. *Psychol. Repts.*, **4**, 351-88 (1958)
 27. Child, I. L. Personality. In *Annual Review of Psychology*, **5**, 1954, 149-70 (Stone, C. P., and McNemar, Q., Eds., Annual Reviews, Inc., Stanford, Calif., 448 pp., 1954)
 28. Chiles, W. D. Effects of shock-induced stress on verbal performance. *J. Exptl. Psychol.*, **56**, 159-65 (1958)
 29. Cohen, J. Subjective probability. *Sci. American*, **197**, 128-38 (1957)
 30. Concordia Theological Seminary, School for Graduate Studies. *What, Then, is Man? A Symposium of Theology, Psychology, and Psychiatry. Graduate Study No. III* (Concordia Publishing House, St. Louis, Mo., 356 pp., 1958)
 31. Cronbach, L. J. The two disciplines of scientific psychology. *Am. Psychologist*, **12**, 671-84 (1957)
 32. Cronbach, L. J., and Meehl, P. E. Construct validity in psychological tests. *Psychol. Bull.*, **52**, 281-302 (1955)
 33. deRivera, J. *The Prediction of Anxiety in Aviation Students. Project NM1601 11, Subtask 11, Rept. No. 1*. (Naval School of Aviation Medicine, Pensacola, Fla., 1957)
 34. DeSoto, C. B., Kuethe, J. L., and Boskey, J. J. A redefinition of social desirability. *J. Abnormal Social Psychol.*, **58**, 273-75 (1959)
 35. Doris, J. Test-anxiety and blame-assignment in grade school children. *J. Abnormal Social Psychol.*, **58**, 181-90 (1959)
 36. Douvan, E., and Adelson, J. The psychodynamics of social mobility in adolescent boys. *J. Abnormal Social Psychol.*, **56**, 31-44 (1958)
 37. Edwards, A. L. *The Social Desirability Variable in Personality Assessment and Research* (The Dryden Press, Inc., New York, N. Y., 108 pp., 1957)
 38. Edwards, W. The prediction of decisions among bets. *J. Exptl. Psychol.*, **50**, 201-14 (1955)
 39. Eriksen, C. W. Unconscious processes. In *Nebraska Symposium on Motivation, 1958*, 169-226 (Jones, M. R., Ed., University of Nebraska Press, Lincoln, Neb., 278 pp., 1958)

40. Eriksen, C. W., Kuethe, J. W., and Sullivan, D. F. Some personality correlates of learning without verbal awareness. *J. Personality*, **26**, 216-28 (1958)
41. Estes, W. K. Stimulus-response theory of drive. In *Nebraska Symposium on Motivation*, 1958, 35-68 (Jones, M. R., Ed., University of Nebraska Press, Lincoln, Neb., 278 pp., 1958)
42. Fager, R. E., and Knopf, I. J. Relationship of manifest anxiety to stimulus generalization. *J. Abnormal Social Psychol.*, **57**, 125-26 (1958)
43. Feather, N. T. Subjective probability and decision under uncertainty. *Psychol. Rev.*, **66**, 150-64 (1959)
44. Feld, S., and Smith, C. P. An evaluation of the objectivity of the method of content analysis. In *Motives in Fantasy, Action, and Society*, Chap. 15, 234-41 (Atkinson, J. W., Ed., D. Van Nostrand, Co., Inc., Princeton, N. J., 873 pp., 1958)
45. Festinger, L. *A Theory of Cognitive Dissonance* (Row, Peterson & Company, Evanston, Ill, 291 pp., 1957)
46. Festinger, L. The motivating effect of cognitive dissonance. In *Assessment of Human Motives*, Chap. 3, 65-86 (Lindzey, G., Ed., Rinehart & Company, Inc., New York, N. Y., 273 pp., 1958)
47. Festinger, L., and Carlsmith, J. M. Cognitive consequences of forced compliance. *J. Abnormal. Social Psychol.*, **58**, 203-10 (1959)
48. French, E. G. Development of a measure of complex motivation. In *Motives in Fantasy, Action, and Society*, Chap. 16, 242-47 (Atkinson, J. W., Ed., D. Van Nostrand, Co., Inc., Princeton, N. J., 873 pp., 1958)
49. French, E. G. Effects of the interaction of motivation and feedback on task performance. In *Motives in Fantasy, Action, and Society*, Chap. 29, 400-08 (Atkinson, J. W., Ed., D. Van Nostrand & Co., Inc., Princeton, N. J., 873 pp., 1958)
50. French, E. G., and Thomas, F. H. The relation of achievement motivation to problem solving effectiveness. *J. Abnormal Social Psychol.*, **56**, 45-48 (1958)
51. Frey, A. H., and Becker, W. C. Some personality correlates of subjects who failed to appear for experimental appointments. *J. Consulting Psychol.*, **22**, 164 (1958)
52. Gerard, H. B. Some effects of involvement upon evaluation. *J. Abnormal Social Psychol.*, **57**, 118-19 (1958)
53. Gill, M. The present state of psychoanalytic theory. *J. Abnormal Social Psychol.*, **58**, 1-8 (1959)
54. Glanzer, M. Curiosity, exploratory drive, and stimulus satiation. *Psychol. Bull.*, **55**, 302-15 (1958)
55. Groesbeck, B. L. Toward description of personality in terms of configuration of motives. In *Motives in Fantasy, Action, and Society*, Chap. 28, 383-99 (Atkinson, J. W., Ed., D. Van Nostrand & Co., Inc., Princeton, N. J., 873 pp., 1958)
56. Haber, R. N., and Alpert, R. The role of situation and picture cues in projective measurement of the achievement motive. In *Motives in Fantasy, Action, and Society*, Chap. 45, 644-63 (Atkinson, J. W., Ed., D. Van Nostrand & Co., Inc., Princeton, N. J., 873 pp., 1958)
57. Hebb, D. O. Alice in wonderland, or, psychology among the biological sciences. In *Biological and Biochemical Bases of Behavior*, 451-67 (Harlow, H. F., and

- Woolsey, C. N., Eds., University of Wisconsin Press, Madison, Wis., 476 pp., 1958)
58. Heyns, R. W., Veroff, J., and Atkinson, J. W. A scoring manual for the affiliation motive. In *Motives in Fantasy, Action, and Society*, Chap. 13, 205-18 (Atkinson, J. W., Ed., D. Van Nostrand & Co., Inc., Princeton, N. J., 873 pp., 1958)
 59. Hill, W. F. Comments on Taylor's "drive theory and manifest anxiety." *Psychol. Bull.*, **54**, 490-93 (1957)
 60. Himmelstein, P., Eschenbach, A. E., and Carp, A. Interrelationships among three measures of need achievement. *J. Consulting Psychol.*, **22**, 451-52 (1958)
 61. Howard, R. C., and Berkowitz, L. Reactions to the evaluators of one's performance. *J. Personality*, **26**, 494-507 (1958)
 62. Jacobs, B. A method for investigating the cue characteristics of pictures. In *Motives in Fantasy, Action, and Society*, Chap. 43, 617-29 (Atkinson, J. W., Ed., D. Van Nostrand Co., Inc., Princeton, N. J., 873 pp., 1958)
 63. Janis, I. L. *Psychological Stress: Psychoanalytic and Behavioral Studies of Surgical Patients* (John Wiley & Sons, Inc., New York, N. Y., 439 pp., 1958)
 64. Janis, I. L. The psychoanalytic interview as an observational method. In *Assessment of Human Motives*, Chap. 6, 149-82 (Lindzey, G., Ed., Rinehart & Company, Inc., New York, N. Y., 273 pp., 1958)
 65. Jessor, R., and Hammond, K. R. Construct validity and the Taylor Anxiety Scale. *Psychol. Bull.*, **54**, 161-70 (1957)
 66. Jones, M. R. (Ed.) *Nebraska Symposium on Motivation, 1958* (University of Nebraska Press, Lincoln, Neb., 278 pp., 1958)
 67. Katchmar, L. T., Ross, S., and Andrews, T. G. Effects of stress and anxiety on performance of a complex verbal-coding task. *J. Exptl. Psychol.*, **55**, 559-63 (1958)
 68. Kausler, D. H., and Trapp, E. P. Achievement motivation and goal-setting behavior on a learning task. *J. Exptl. Psychol.*, **55**, 575-77 (1958)
 69. Kausler, D. H., and Trapp, E. P. Relationship between achievement motivation scores and manifest anxiety scores. *J. Consulting Psychol.*, **22**, 448-50 (1958)
 70. Kausler, D. H., and Trapp, E. P. Methodological considerations in the construct validation of drive-oriented scales. *Psychol. Bull.*, **56**, 152-57 (1959)
 71. Klein, G. S. Cognitive control and motivation. In *Assessment of Human Motives*, Chap. 4, 87-118 (Lindzey, G., Ed., Rinehart & Company, Inc., New York, N. Y., 273 pp., 1958)
 72. Klein, G. S., Spence, D. P., Holt, R. R., and Gourevitch, S. Cognition without awareness: subliminal influences upon conscious thought. *J. Abnormal Social Psychol.*, **57**, 255-66 (1958)
 73. Klopfer, B. (Ed.) A birthday tribute to Henry A. Murray—TAT issue. *J. Projective Techniques*, **22**, 143-257 (1958)
 74. Knapp, R. H. Achievement and aesthetic preference. In *Motives in Fantasy, Action, and Society*, Chap. 26, 367-72 (Atkinson, J. W., Ed., D. Van Nostrand Co., Inc., Princeton, N. J., 873 pp., 1958)
 75. Knapp, R. H., and Garbutt, J. T. Time imagery and the achievement motive. *J. Personality*, **26**, 426-34 (1958)
 76. Koch, S. Behavior as "intrinsically" regulated: work notes towards a pretheory

- of phenomena called "motivational." In *Nebraska Symposium on Motivation, 1956*, 42-86 (Jones, M. R., Ed., University of Nebraska Press, Lincoln, Neb., 311 pp., 1956)
77. Kuethe, J. L. The positive response set as related to task performance. *J. Personality*, **27**, 87-94 (1958)
 78. Lazarus, R. S., Backer, R. W., Broverman, D. M., and Mayer, J. Personality and psychological stress. *J. Personality*, **25**, 559-77 (1957)
 79. Lesser, G. Application of Guttman's scaling method to aggressive fantasy in children. *Educ. Psychol. Measurement*, **18**, 543-50 (1958)
 80. Levin, H., and Baldwin, A. L. The choice to exhibit. *Child Development*, **29**, 373-80 (1958)
 81. Levinson, D. J. Role, personality, and social structure in the organizational setting. *J. Abnormal Social Psychol.*, **58**, 170-80 (1959)
 82. Lewin, K. *Dynamic Theory of Personality* (McGraw-Hill Book Co., New York, N. Y. and London, England, 286 pp., 1935)
 83. Lewin, K. *Field Theory in Social Science*, Chap. 10, 238-303 (Cartwright, D., Ed., Harper & Brothers, New York, N. Y., 346 pp., 1951)
 84. Lewin, K., Dembo, T., Festinger, L., and Sears, P. S. Level of aspiration. In *Personality and the Behavioral Disorders*, **1**, Chap. 10, 333-78 (Hunt, J. McV., Ed., The Ronald Press Company, New York, N. Y., 618 pp., 1944)
 85. Lindzey, G. Thematic apperception test: the strategy of research. *J. Projective Techniques*, **22**, 173-80 (1958)
 86. Lindzey, G. (Ed.) *Assessment of Human Motives* (Rinehart & Company, Inc., New York, N. Y.; 273 pp., 1958)
 87. Lindzey, G. On the classification of projective techniques. *Psychol. Bull.*, **56**, 158-68 (1959)
 88. Lindzey, G., and Kalmins, D. Thematic apperception test: some evidence bearing on the "hero assumption." *J. Abnormal Social Psychol.*, **57**, 76-83 (1958)
 89. Lipsitt, L. P. A self-concept scale for children and its relationship to the children's form of the Manifest Anxiety Scale. *Child Development*, **29**, 463-72 (1958)
 90. Littig, L. W. The effect of motivation on probability preferences and subjective probability (Doctoral thesis, Univ. of Michigan, Ann Arbor, Mich., 1959)
 91. Littman, R. A. Motives, history, and causes. In *Nebraska Symposium on Motivation, 1958*, 114-68 (Jones, M. R., Ed., University of Nebraska Press, Lincoln, Neb., 278 pp., 1958)
 92. Loehlin, J. C. The influence of different activities on the apparent length of time. *Psychol. Monographs*, **73**, 27 pp. (1959)
 93. Lucas, J. D. The interactive effects of anxiety, failure and intraserial duplication. *Am. J. Psychol.*, **65**, 59-66 (1952)
 94. Mahone, C. H. Fear of failure and unrealistic vocational aspiration. (Unpublished doctoral thesis, Univ. of Michigan, Ann Arbor, Mich. 1958)
 95. Mandler, G., and Cowen, J. E. Test anxiety questionnaires. *J. Consulting Psychol.*, **22**, 228-29 (1958)
 96. Mandler, G., and Kremen, I. Autonomic feedback: a correlational study. *J. Personality*, **26**, 388-99 (1958)
 97. Mandler, G., Mandler, J. M., and Uviller, E. T. Autonomic feedback: the perception of autonomic activity. *J. Abnormal Social Psychol.*, **56**, 367-73 (1958)

98. Mandler, G., and Sarason, S. B. A study of anxiety and learning. *J. Abnormal Social Psychol.*, **16**, 115-18 (1952)
99. Martin, R. M., and Marcuse, F. L. Characteristics of volunteers and non-volunteers in psychological experimentation. *J. Consulting Psychol.*, **22**, 475-79 (1958)
100. McClelland, D. C. Methods of measuring human motivation. In *Motives in Fantasy, Action, and Society*, Chap. 1, 7-42 (Atkinson, J. W., Ed., D. Van Nostrand Co., Inc., Princeton, N. J., 873 pp., 1958)
101. McClelland, D. C. Risk taking in children with high and low need for achievement. In *Motives in Fantasy, Action, and Society*, Chap. 21, 306-21 (Atkinson, J. W., Ed., D. Van Nostrand Co., Inc., Princeton, N. J., 873 pp., 1958)
102. McClelland, D. C. The use of measures of human motivation in the study of society. In *Motives in Fantasy, Action, and Society*, Chap. 37, 518-52 (Atkinson, J. W., Ed., D. Van Nostrand Co., Inc., Princeton, N. J., 873 pp., 1958)
103. McClelland, D. C., Atkinson, J. W., Clark, R. A., and Lowell, E. L. *The Achievement Motive* (Appleton-Century-Crofts, Inc., New York, N. Y., 384 pp., 1953)
104. McClelland, D. C., Baldwin, A. L., Bronfenbrenner, U., and Strotbeck, F. L. *Talent and Society: New Perspectives in the Identification of Talent* (D. Van Nostrand Co., Inc., Princeton, N. J., 275 pp., 1958)
105. McConnell, J. V., Cutler, R. L., and McNeil, E. B. Subliminal stimulation: an overview. *Am. Psychologist*, **13**, 229-42 (1958)
106. Melikian, L. H. The relationship between Edwards' and McClelland's measures of achievement motivation. *J. Consulting Psychol.*, **22**, 296-98 (1958)
107. Meyer, D. R., and Noble, M. E. Summation of manifest anxiety and muscular tension. *J. Exptl. Psychol.*, **55**, 599-602 (1958)
108. Miller, D. R., and Swanson, G. E., The study of conflict. In *Nebraska Symposium on Motivation, 1956*, 137-73 (Jones, M. R., Ed., University of Nebraska Press, Lincoln, Neb., 311 pp., 1956)
109. Miller, D. R., and Swanson, G. E. *Inner Conflict and Defense* (Henry Holt & Co., Inc., New York, N. Y., 1960)
110. Miller, N. E. Liberalization of basic S-R concepts: extensions to conflict behavior, motivation, and social learning. In *Psychology: A Study of a Science. Study I*, **2**, 196-202 (Koch, S., Ed., McGraw-Hill Book Co., New York, N. Y., 706 pp., 1959)
111. Mills, J. Changes in moral attitudes following temptation. *J. Personality*, **26**, 517-31 (1958)
112. Moulton, R. W. Notes for a projective measure of fear of failure. In *Motives in Fantasy, Action, and Society*, Chap. 39, 563-71 (Atkinson, J. W., Ed., D. Van Nostrand Co., Inc., Princeton, N. J., 873 pp., 1958)
113. Moulton, R. W., Raphelson, A. C., Kristofferson, A. G., and Atkinson, J. W. The achievement motive and perceptual sensitivity under two conditions of motive arousal. In *Motives in Fantasy, Action, and Society*, Chap. 24, 350-59 (Atkinson, J. W., Ed., D. Van Nostrand Co., Inc., Princeton, N. J., 873 pp., 1958)
114. Murstein, B. I. A conceptual model of projective techniques applied to stimulus variations with thematic techniques. *J. Consulting Psychol.*, **23**, 3-14 (1959)

115. Nicholson, W. M. The influence of anxiety upon learning: interference or drive increment? *J. Personality*, **26**, 303-19 (1958)
116. Olds, J. Adaptive functions of paleocortical and related structures. In *Biological and Biochemical Bases of Behavior*, 237-62 (Harlow, H. F., and Woolsey, C. W., Eds., University of Wisconsin Press, Madison, Wis., 476 pp., 1958)
117. Olds, J. Self-stimulation of the brain. *Science*, **127**, 315-24 (1958)
118. Peak, H. Psychological structure and psychological activity. *Psychol. Rev.*, **65**, 325-47 (1958)
119. Pepinsky, P. N., Hemphill, J. K., and Shevitz, R. N. Attempts to lead, group productivity, and morale under conditions of acceptance and rejection. *J. Abnormal Social Psychol.*, **57**, 47-54 (1958)
120. Peters, R. S. *The Concept of Motivation* (George Routledge & Kegan Paul, Ltd., London, England; Humanities Press, New York, N. Y., 166 pp., 1958)
121. Purcell, K. Some shortcomings in projective test validation. *J. Abnormal Social Psychol.*, **57**, 115-17 (1958)
122. Raphelson, A. C. The relationship between imaginative, direct verbal, and physiological measures of anxiety in an achievement situation. *J. Abnormal Social Psychol.*, **54**, 13-18 (1957)
123. Raphelson, A. C., and Moulton, R. W. The relationship between imaginative and direct verbal measurements of test anxiety under two conditions of uncertainty. *J. Personality*, **26**, 556-67 (1958)
124. Reitman, W. R., and Atkinson, J. W. Some methodological problems in the use of thematic apperceptive measures of human motives. In *Motives in Fantasy, Action, and Society*, Chap. 46, 664-83 (Atkinson, J. W., Ed., D. Van Nostrand Co., Inc., Princeton, N. J., 873 pp., 1958)
125. Romanow, C. V. Anxiety level and ego involvement as factors in concept formation. *J. Exptl. Psychol.*, **56**, 166-73 (1958)
126. Rosen, B. C., Race, ethnicity, and the achievement syndrome. *Am. Sociol. Rev.*, **24**, 47-60 (1959)
127. Rosenzweig, S. An experimental study of "repression" with special reference to need-persistent and ego defensive reactions to frustration. *J. Exptl. Psychol.*, **32**, 64-74 (1943)
128. Rotter, J. B. *Social Learning and Clinical Psychology* (Prentice-Hall, Inc., New York, N. Y., 466 pp., 1954)
129. Samelson, F. The relation of achievement and affiliation motives to conforming behavior in two conditions of conflict with a majority. In *Motives in Fantasy, Action, and Society*, Chap. 31, 421-34 (Atkinson, J. W., Ed., D. Van Nostrand Co., Inc., Princeton, N. J., 873 pp., 1958)
130. Sarason, S. B., Davidson, K., Lighthall, F., and Waite, R. Classroom observations of high and low anxious children. *Child Development*, **29**, 287-96 (1958)
131. Sarason, S. B., Davidson, K., Lighthall, F., and Waite, R. Rorschach behavior and performance of high and low anxious children. *Child Development*, **29**, 277-86 (1958)
132. Sarason, S. G., Mandler, G., and Craighill, P. G. The effect of differential instructions on anxiety and learning. *J. Abnormal Social Psychol.*, **47**, 561-65 (1952)
133. Schönbach, P. Cognition, motivation, and time perception. *J. Abnormal Social Psychol.*, **58**, 195-202 (1959)

134. Scodel, A. Some personality correlates of decision making under conditions of risk. *Behavioral Sci.*, **4**, 19-28 (1959)
135. Sears, R. R. Functional abnormalities of memory with special reference to amnesia. *Psychol. Bull.*, **33**, 229-74 (1936)
136. Sears, R. R. Initiation of the repression sequence by experienced failure. *J. Exptl. Psychol.*, **7**, 151-63 (1937)
137. Sears, R. R. Success and failure: a study of motility. In *Studies in Personality*, Chap. 13, 235-59 (McNemar, Q., and Merrill, M., Eds., McGraw-Hill Book Co., New York, N. Y., 333 pp., 1942)
138. Sears, R. R. Personality. In *Annual Review of Psychology*, **1**, 105-18 (Stone, C. P., and Taylor, D. W., Eds., Annual Reviews, Inc., Stanford, Calif., 330 pp., 1950)
139. Smith, C. P., and Feld, S. How to learn the method of content analysis for n Achievement, n Affiliation, and n Power. In *Motives in Fantasy, Action, and Society*, Appendix I, 685-818 (Atkinson, J. W., Ed., D. Van Nostrand Co., Inc., Princeton, N. J., 873 pp., 1958)
140. Spence, K. W. *Behavior Theory and Conditioning* (Yale University Press, New Haven, Conn., 262 pp., 1956)
141. Spence, K. W. A theory of emotionally based drive (D) and its relation to performance in simple learning situations. *Am. Psychologist*, **13**, 131-41 (1958)
142. Spence, K. W. Behavior theory and selective learning. In *Nebraska Symposium on Motivation, 1958*, 73-107 (Jones, M. R., Ed., University of Nebraska Press, Lincoln, Neb., 278 pp., 1958)
143. Sperber, Z. The test anxiety questionnaire: scoring norms for a non-college population. *J. Abnormal Social Psychol.*, **58**, 129-30 (1959)
144. Spielberger, C. D. On the relationship between manifest anxiety and intelligence. *J. Consulting Psychol.*, **22**, 220-24 (1958)
145. Spielberger, C. D., Goodstein, L. D., and Dahlstrom, W. G. Complex incidental learning as a function of anxiety and task difficulty. *J. Exptl. Psychol.*, **56**, 58-61 (1958)
146. Taylor, J. A. Drive theory and manifest anxiety. *Psychol. Bull.*, **53**, 303-20 (1956)
147. Taylor, J. A. The effects of anxiety level and psychological stress on verbal learning. *J. Abnormal Social Psychol.*, **57**, 55-60 (1958)
148. Taylor, J. A., and Reichtschaffen, A. Manifest anxiety and reversed alphabet printing. *J. Abnormal Social Psychol.*, **58**, 221-24 (1959)
149. Tolman, E. C. *Behavior and Psychological Man* (University of California Press, Berkeley, Calif., 269 pp., 1958; *Collected Papers in Psychology* (University of California Press, Berkeley, Calif., 269 pp., 1951)
150. Tolman, E. C. Principles of purposive behavior. In *Psychology: A Study of a Science. Study I.*, **2**, 92-157 (Koch, S., Ed., McGraw-Hill Book Co., New York, N. Y., 706 pp., 1959)
151. Toman, W. A general formula for the quantitative treatment of human motivation. *J. Abnormal Social Psychol.*, **58**, 91-99 (1959)
152. Veroff, J. A scoring manual for the power motive. In *Motives in Fantasy, Action, and Society*, Chap. 14, 219-33 (Atkinson, J. W., Ed., D. Van Nostrand Co., Inc., Princeton, N. J., 873 pp., 1958)

153. Vogel, W., Baker, R. W., and Lazarus, R. S. The roles of motivation in psychological states. *J. Abnormal Social Psychol.*, **56**, 105-12 (1958)
154. Vogel, W., Raymond, S., and Lazarus, R. S. Intrinsic motivation and psychological stress. *J. Abnormal Social Psychol.*, **58**, 225-33 (1959)
155. Waite, R. R., Sarason, S. B., Lighthall, F. F., and Davidson, K. S. Learning in children. *J. Abnormal Social Psychol.*, **57**, 267-70 (1958)
156. Walker, E. L., Atkinson, J. W., Veroff, J., Birney, R. C., Dember, W., and Moulton, R. W. The expression of fear-related motivation in thematic apperception as a function of proximity to an atomic explosion. In *Motives in Fantasy, Action, and Society*, Chap. 10, 143-59 (Atkinson, J. W., Ed., D. Van Nostrand Co., Inc., Princeton, N. J., 873 pp., 1958).
157. Winterbottom, M. R. The relation of need for achievement to learning experiences in independence and mastery. In *Motives in Fantasy, Action, and Society*, Chap. 33, 453-78 (Atkinson, J. W., Ed., D. Van Nostrand Co., Inc., Princeton, N. J., 873 pp., 1958)
158. Young, P. T. The role of affective process in learning and motivation. *Psychol. Rev.*, **66**, 104-25 (1959)

PSYCHOLINGUISTICS¹

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Since the last *Annual Review of Psychology* carrying a section pertaining to psycholinguistics appeared in 1954 (G. A. Miller's review of communication), we undertook to survey the literature from 1954 through 1958. We covered all relevant American journals and, in addition, whichever British, Canadian, French, and Russian journals were available to us. The number of works one might properly include under psycholinguistics is quite large; because of the limitation of space, however, we were forced to omit all but the most germane. We hope that extending the survey of psycholinguistics closer to the present will encourage more frequent review of the field.

Psycholinguistics is not a well-integrated field of study, and one can hardly speak of anything like a general trend in the field as a whole. Nevertheless, a number of studies concerned with the probability of language segments and with word association have brought forth a point of view which stresses the significance of the concept of response hierarchy in interpreting the subject's performance in various verbal tasks. These studies have suggested, and to some extent supported, the following hypotheses:

(a) Differential exposure to language segments (letters, words, etc.) produces in the individual a set of correlated probabilities of emitting those segments.

(b) Since segments in natural languages are characterized by inequality in frequency of occurrence, experience with language—both in sending and receiving messages—imparts to the individual an isomorphic response hierarchy.

(c) Because members of the same linguistic community share a common language experience, their response hierarchies are similar.

(d) Similarity among the responses at a given probability rank in the hierarchies of the members of a linguistic community decreases as the rank-number increases.

(e) The effect of a stimulus (e.g., the effect of context in prediction) is to modify the response hierarchy so that the probabilities of emitting certain responses are greatly reduced, while the relative probabilities of the other responses are left more or less unchanged.

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(f) The proportion of responses emitted by a group of subjects which is "correct," i.e., identical with the test segment (e.g., the word to be predicted or recognized), depends upon the mean rank of that segment in the subjects' response hierarchies. The lower its rank-number, the greater the probability it will be emitted by any individual subject, and, consequently, the more subjects will emit it.

PROBABILITY OF LANGUAGE SEGMENTS

The abundant research concerned with the relationship between the probability of language segments (letters, phonemes, words) and behaviors like learning, recognition, and prediction is discussed in three sections according to the linguistic-probability variable: redundancy, frequency of occurrence, and inventory size. The results are of two general varieties: those that contribute to our knowledge of the probability structure of language, and those that confirm the positive relationship between the probability of the language segments and performance in recognition, prediction, and (with some reservations) learning.

Redundancy.—If messages are composed in such a way that there is dependence between message segments, then the code governing the organization of these messages may be said to be characterized by some degree of redundancy—the greater the dependence, the greater the redundancy.

Research in redundancy has been concerned with two questions: What are its effects, and what determines its degree? The effects of redundancy have been studied primarily with regard to learning and recognition. All studies show that greater redundancy tends to facilitate performance. In the case of learning, Adelson, Muckler & Williams (3) compared the learning of letters in redundant and nonredundant lists and found that redundant lists were learned in fewer trials. Rubenstein & Aborn (126), using passages derived from nonsense languages of various degrees of redundancy, found that a greater number of syllables but less information were recalled as the redundancy of the languages increased. Miller (100) obtained the same result with random and redundant strings of letters. Sharp (135) found that learning increased with the order of approximation to English (the higher the order, the greater the redundancy). Deese & Kaufman (43) investigated the serial position curve of the words recalled from lists of various orders of approximation to English. As the approximation rose, there was an increasing tendency for words to be recalled in the order in which they were presented and, further, for more words to be recalled from the beginning of the list than from the end. The serial position function thus changed from that characteristic of the free recall of nonsense material to that characteristic of serial anticipation.

In recognition, O'Neill (113) confirmed the finding of G. A. Miller, Heise & Lichten (105) that more words were recognized in noise when presented in sentences than when presented in isolation. Both studies report that there was about a 6 db. difference in threshold for 50 per cent of words correct

between the two conditions. I. Miller (107), similarly studying auditory recognition in noise, found that more bisyllables were recognized in more redundant nonsense languages than in less redundant languages. No constancy could be observed either in terms of transmitted information or information in correct responses, both of which increased with the information per item. In contrast, G. A. Miller, Bruner & Postman (104), investigating visual recognition of 8-letter sequences of various orders of approximation to English, did find the amount of information in correct responses to be approximately constant over the orders of approximation tested.

Various tasks have been shown to be related to degree of redundancy. Sumby & Pollack (143) found that speed in typing, speed, errors, and glances per word in writing, and speed in reading aloud were all related to order of approximation to English. Pierce & Karlin (121) found that rate of reading aloud was faster in ordinary prose than in scrambled prose. (Although in the remaining studies dependence was of a much looser kind, the same general increase in correct responses was obtained with increasing redundancy.) Cofer & Shepp (40) compared the visual recognition of words in isolation and in context with their synonyms. Taylor (145) compared the visual recognition of words in isolation and in the context of words associated with them. Bruce (23) compared the auditory recognition of sentences in isolation, in the context of a correct description of their topic, and in the context of a false description of their topic. In another experiment, Bruce (22) used a device which might perhaps be called "implicit" dependence. He compared the auditory recognition of words which were all names of foods (something the subjects had to discover for themselves) with the auditory recognition of a set of words having no common superordinate.

The direct measurement of redundancy is not always feasible, especially when segments longer than letters or phonemes are being considered. Most investigations of the factors affecting redundancy have therefore employed the technique of having subjects predict missing language segments or of having subjects predict replacements for incorrect language segments—under the assumption that predictability and redundancy are closely related. Since such prediction tasks bring a number of language habits into play, however, the obtained estimates of redundancy are probably considerably lower than estimates based upon the performance of an "ideal predictor."

Two general factors affecting redundancy have been discovered so far: the length of context and the distribution of context (i.e., whether it precedes, surrounds, or follows the segment to be predicted). Although the fact that redundancy increases with length of context has been well established by previous research, several recent studies have brought forth additional results of interest. Sumby & Pollack's (143) findings show that the uncertainty of prediction is about 1.5 bits greater for the initial letter than for the mean of all the remaining letters in monosyllabic words. This difference was approximately constant for all orders of approximation to English. Fair-

banks & Kodman (47), using a known inventory of 50 words, had subjects predict the words on the basis of their constituent phonemes. They found that the proportion of correct predictions was a sigmoid function of the proportion of phonemes shown (without indication of the position of the phonemes in the word). Morrison & Black (108) obtained a word predictability of 19 per cent when six words were omitted (position of omission shown) in sentences 11 to 13 words long and of 53 per cent when only one word was omitted.

Predictably, the effect of increasing length of context soon reaches an asymptote. Burton & Licklider (27), using Shannon's multiple guessing technique, found that the predictability of letters does not increase appreciably once the preceding context has reached the length of 32 letters. The asymptote for words, however, is not so clearly delimited. Sharp (135) found that the probability of the most frequently elicited response in the production of orders of approximation to English did not show appreciable increase after the fifth order. For bilaterally distributed context, there was Taylor's (147, fn. 10) finding that "the subject's performances on successive blanks created by every-fifth-word deletion are statistically independent." This would appear to place the upper bound of the length of relevant context at four words on either side of the dependent. Of course, the limit of length of relevant context varies with the particular task. Thus, according to Levine's (98, pp. 135-36) finding, the number of words recalled is affected by redundancy even greater than that of the seventh order of approximation.

According to Garner (52a), since the degree of dependence of one segment upon another decreases with increase in the distance between the segments (accounting for the shape of the function of redundancy on length-of-context), it follows mathematically that a segment is more redundant when it is surrounded by context than when it is preceded or followed by context of the same length. The experimental results of Miller & Friedman (101) bear Garner out: these workers found in sequences of 11 letters (word space included as a letter) that the sixth letter had a predictability of over 95 per cent while the eleventh letter had a predictability of about 60 per cent and the first letter a predictability of about 50 per cent. Similarly, Bruner & O'Dowd (24) found in tachistoscopic presentation that word recognition was most successful when the typographical reversal of letters occurred medially and least successful when the reversal occurred initially.

It should be noted that Miller & Friedman found the last letter of a sequence to be considerably more predictable than the first. However, as they pointed out, this is not attributable to differences in redundancy; rather, it is attributable to the alphabetizing habits of subjects—habits which make it easier for them to think of sequences beginning with the given letters than to think of sequences ending with the given letters. On first consideration, Bruner & O'Dowd's finding of greater recognition for reversals in final position than in initial position suggests the same explanation. Melville's (97) observation that more words were correctly recognized when their first

letters were close to the fixation point in tachistoscopic presentation than when their last letters were suggests the same explanation. Actually, the latter two experiments differed from the experiment of Miller & Friedman in one important respect: both employed single words as stimuli, while in the Miller & Friedman experiment the letter sequences were selected randomly and were, therefore, not necessarily coterminous with words. The findings of Bruner & O'Dowd and of Melville then—in contrast to those of Miller & Friedman—are to be explained at least in part by the fact that the final letter of a word is more redundant than the initial letter.

Several investigators have studied prediction when there is uncertainty about not only what is omitted, but also where the omission occurs. Chapanis (33) showed that with 25 per cent random deletion of letters, word spaces, and punctuation, subjects could restore about 60 per cent of the missing segments, while with a 50 per cent deletion, only about 10 per cent of the missing segments could be correctly restored. Miller & Friedman (101) found that subjects were most successful in reconstructing passages in which characters chosen at random were inserted between successive characters of the original text. Their results for random deletion are quite close to those reported by Chapanis. Morrison & Black (108) investigated word prediction in sentences 11 to 13 words long in which one to six words were deleted. Their results show, of course, that word prediction is more difficult than letter prediction. The per cent of correct word predictions when three words (25 per cent of the sentence) were omitted (with position indicated) was 39, whereas Miller & Friedman found 90 per cent correct letter predictions for the same proportion of letter deletions. When more than one word was omitted, relatively little difference was observed among these three experimental conditions: (a) where the position of omission was indicated, (b) where it was not indicated, (c) and where the order of words constituting the context was randomized—except when semantically similar responses were also scored as correct.

There are obviously other factors in predictability besides the length and distribution of the context. Goldman-Eisler (55) reported that the predictability of occurring words after a pause in speech is much lower than predictability of words coming before a pause. Another of her findings—a low correlation between the predictability of a word on the basis of its preceding context and the predictability of a word on the basis of its succeeding context—indicates that research into the grammatical aspects of context might be fruitful.

Several investigators have studied the relationship between the predictability of a letter or a word and diversity of response. Miller & Friedman (101) found with letters that single-guess prediction is related to the results of Shannon's method, according to which subjects continued to guess until they made the correct response, by the equation $H = 5(1 - P)$, where P is the probability of being right on the first guess. Taylor (147) found a correlation of $-.87$ between the single-guess predictability of a word in bilaterally dis-

tributed context and the entropy of the subjects' responses. Similarly, Goldman-Eisler (55) found that words of low predictability elicited more different responses under the method of continuous prediction.

Certain correlations have been reported where both variables are themselves related to redundancy. Taylor (147), for example, found a coefficient of .8 between the predictability of words in passages of text and the comprehensibility of passage content. Similarly, Rubenstein & Aborn (127) found a coefficient of .7 between the mean word predictability of passages of text and the number of words recalled.

Frequency of occurrence.—Word frequency has become a most ubiquitous variable in psycholinguistic research—not only because the Thorndike-Lorge (149) count has made the requisite data available, but because of the power of its effect. This was brought to attention in earlier studies, such as that of Howes & Solomon (69), and made quite evident in experiments such as those of Baker & Feldman (5) and King-Ellison & Jenkins (76), which showed that even laboratory-produced frequency differences are effective. Although word frequency has been studied primarily in connection with recognition, there are a few studies in which its effect in learning and other tasks has been demonstrated: Bousfield, Cohen & Whitmarsh (13) found that frequency was significantly related to both the number of words recalled and the amount of clustering; Hall (57) found a significant positive correlation between the Thorndike-Lorge value of a word and the number of subjects able to recall it. In experiments involving tasks other than learning, Pierce & Karlin (121) found that word frequency was positively related to rate of reading aloud; Battig (7) reported some influence of word frequency in a letter guessing task; and Aborn & Rubenstein (2) found that subjects' judgments of the probability with which words occur in a given context were related to the frequency with which those words were offered as alternatives in that context.

Two very interesting studies appeared recently in auditory recognition in noise, one by Rosenzweig & Postman (124) and the other by Howes (66). The fact that the former experiment was restricted to monosyllables may account for the difference in the relation between log frequency and speech-to-noise ratio, which was about 3.3 db per log unit of frequency in the Rosenzweig & Postman experiment and 4.5 db per log unit of frequency in the Howes experiment. In the same study, Rosenzweig & Postman tested French words on French subjects with results quite similar to those obtained in the English experiment. It is interesting to observe that the correlations between threshold and log frequency in both these studies agree closely with the correlation reported by Howes & Solomon (69) for visual recognition: all are between $-.7$ and $-.8$. Among experiments in visual recognition, we may cite those of Baker & Feldman (5) and King-Ellison & Jenkins (76), in which recognition threshold was shown to be a function of the log frequency of exposure during training.

Some investigators, like Taylor (146), have considered that frequency of

occurrence might be made up of something beyond frequency of exposure, something called "meaningfulness." Taylor repeatedly presented syllables accompanied by colored pictures of familiar objects to one group of subjects. To another group, she presented the syllables alone, but equally frequently. No significant difference between the recognition thresholds of the groups was obtained.

There has been some interest in determining whether experience in emission (speaking or writing) is more responsible for the effect of word frequency on recognition than experience in reception (hearing or reading). Howes (64) advanced the opinion that experience in emission plays the greater role in visual recognition. This contention is supported by Daston's (42) finding that subjects were more successful in the visual recognition of words which they themselves emitted frequently in therapy interviews than in the recognition of words which were of equal frequency according to the Thorndike-Lorge count. Contrary evidence, however, was offered by Neisser (110), who found that while the previous study of words lowered their duration thresholds, it did not facilitate the recognition of their homonyms.

While the question of emission vs. reception may still be unresolved, it seems quite certain that the frequency effect of auditory or visual exposure may be transferred from one sense modality to the other: Postman & Rosenzweig (122) demonstrated that frequency of visual exposure facilitated auditory recognition, while Forrest (50) and Weissman & Crockett (153) demonstrated that frequency of auditory exposure facilitated visual recognition.

To many investigators, the word-frequency effect in recognition finds its explanation in the view that greater experience with a given word enables the subject to see or hear it better than a word with which he has had less experience. A recent experiment by Goldiamond & Hawkins (53) forces reconsideration of this view. During pretest training, nonsense syllables were presented to the subjects with differential frequencies of occurrence. The subjects were then informed that these same syllables were going to be shown on the tachistoscope subliminally. They were to respond until the experimenter said "Correct." Actually, no stimulus was presented. The experimenter said "Correct" when the subject emitted the syllable which had been designated beforehand as the "correct" one for that particular trial. (Each syllable was used as the "correct" one for one trial.) It was found that the number of "correct" responses was a direct linear function of the log frequency of exposure of the "correct" word in the training period and that the number of "false" responses the subject made before giving the "correct" one was an inverse linear function of the log of this frequency.

Inventory size.—A simple way of varying probability of occurrence is to vary the total number of items in the inventory. This has been done in a number of studies in recognition and learning. The striking discovery is that inventory size is effective in the former, but not in the latter.

With recognition, two experimental conditions have been employed: one

in which the inventory is known to the subjects, and the other in which it is unknown to them. Bruner, Miller & Zimmerman (25) reported that, when the inventory is unknown, auditory recognition is independent of its size. On the other hand, they, as well as Sumby & Pollack (144), reported that, when the inventory is known, success in auditory recognition decreases with inventory size. This corroborates the finding of Miller, Heise & Lichten (105). Bruner, Miller & Zimmerman reported another finding for the known-inventory condition: despite the decrease in correct identifications with inventory size, the informational measure (the product of the proportion of words correct and the information per word) is approximately constant for all inventory sizes. It should be noted, however, that their tests were run at only one speech-to-noise ratio.

Up to this point, all the studies have shown that increasing the probability of the linguistic items results in an improvement of scores in the given task. In memorization, however, increasing the inventory beyond two or four items has been demonstrated to have very little effect despite the increase in the information per item. Hayes (99, p. 92) found that memory span for binary digits was not much greater than memory span for monosyllabic English words (nine binary digists, five monosyllabic words), despite the fact that each English word contained 10 times as much information. The same phenomenon has been observed in memorization involving practice. For example, Adelson, Muckler & Williams (3) found that in learning standard lists of 15 letters, the number of trials to criterion increased from about seven, for a two-letter inventory, to about 17, for a six-letter inventory. With a 15-letter inventory, 17 trials were still all that were required. Smith (98, pp. 132-33) similarly found that subjects required the same number of trials for lists made up from an eight-word inventory as for lists made up from a 32-word inventory.

Miller (98) has offered a very reasonable explanation of why, with sequentially dependent (redundant) passages, the amount learned depends upon the probability of the alternatives, while with passages or lists containing no sequential dependence, the amount learned is more or less independent of the probability of the alternatives. He suggested that human memory is not limited by the amount of information but rather by the number of units (digits, letters, words, etc.) it can hold. In a passage of sequentially independent words, each word is a unit and takes up a certain portion of the memory capacity, regardless of its probability. In a passage of sequentially dependent words, on the other hand, the dependence permits the combination of words into larger units—"chunks" as Miller calls them. Since the probability of the alternatives determines the extent of "chunking," the greater the probability of sequentially dependent alternatives in a passage, the fewer (but longer) units it contains and the more easily it may be learned. As Miller pointed out, his concept of chunking is closely related to Bousfield's associative clustering, that is, the tendency for subjects learning a list of words to recall the words in groups according to some semantic commonal-

ity. Sakoda (130) has shown that the greater the amount of clustering, the more words recalled—just as it is hypothesized that the more chunking a sequence permits, the more items will be learned.

Interestingly enough, the rate of reading aloud was found by Sumby & Pollack (143) and Pierce & Karlin (121) to resemble immediate memory in being relatively unaffected by the number of words in the inventory from which the list was compiled.

WORD ASSOCIATION

It is quite apparent that the source for communal word associations, if not for idiosyncratic associations, must lie in common language experience. This was clearly demonstrated by Howes (67) when he showed that a close correlation exists between the frequency with which a word occurs as an associate (pooling all stimulus words) and its Thorndike-Lorge frequency. Additional evidence comes from Saporta (132), who observed that, when subjects made up sentences using words from the Kent-Rosanoff (128) list, there were consistent positive correlations between the frequency with which certain words occurred in these sentences and the frequency with which they occurred as associates. Saporta's finding suggests that some associations result from frequent co-occurrence in the same utterances, and the demonstration of this effect on associative strength was given by Peterson (118) and Osgood & Anderson (114). They found that the frequency with which associates were paired in the test situation matched the frequency with which the pair was presented during the training session.

The word frequency of the stimulus was found by Hall & Ugelow (58) to be positively related to the variability of responses and by Carlson (29) to be positively related to the subjects' failures to reproduce their associations during retesting. These two findings are brought together by Laffal (79), who reported a high correlation between subjects' failures to recall their associations and the diversity of associative responses. With regard to latency of response, however, DeLucia & Stagner (44), Carlson (29), and Howes (65) found the word frequency of the stimulus to be of no significance—Hall & Ugelow (58) dissenting.

There has been a fairly long-standing interest in the question of how the grammatical class of the stimulus and the grammatical class of the associate are related. This is no idle query, since the relationship is important for understanding the connection between associations and language experience. If one takes the view that associations stem from language experience, how does one account for the absence of function words and for collocations that are relatively infrequent in speech, e.g., an adjective response to an adjective stimulus? Howes (67) suggested that the absence of function words among the stimuli indicates to the subjects that one of the rules of the game is not to respond with function words. When function words were included among the stimuli, Howes reported a 200-fold increase in the number of function words as responses. Unfortunately, he gave no analysis of the pro-

portions of these function-word responses according to content-word stimuli and function-word stimuli. Other possible factors contributing to the absence of function words, it seems to us, are: (a) most function words precede the words to which they are bound, and (b) the noun-stimuli are given in the singular form not preceded by "the" or "a," thus providing no stimulation for continuation of the utterance.

Saporta (132) suggested that words may be associated paradigmatically, i.e., occupy the same position in different occurrences of the same context, or syntagmatically, i.e., often occur together in the same utterance. In the case of many pairs, however, it is difficult to determine which of these relationships is operative. Perhaps there would be less difficulty if one tested native speakers of a language with a rich morphology, like Russian. The findings of Siipola, Walker & Kolb (136) suggest that paradigmatic associations are made more frequently when the word association task is administered under conditions of time pressure. They reported that the proportion of adjective responses to adjective stimuli increased from 35 per cent under permissive testing conditions to 58 per cent under conditions of pressure and that the proportion of noun responses to noun stimuli increased from 78 per cent to 84 per cent under the same alternative conditions.

The effect of context was investigated in two studies. Cofer & Ford (39) used a synonym as the context of the word to which subjects were to associate. The hypothesis that the context would reduce the latency of response was not supported. Howes (65), in discussing this experiment, pointed out that prior presentation of a synonym increases the probability of occurrence of the stimulus word, but that latency—in contrast to recognition (40)—is a function of the probability of the response word, not the stimulus word. Howes & Osgood (68) carried out a very interesting experiment in which the stimulus word was preceded by a context of three words. It was found that the effect of a given context word increases with its Thorndike-Lorge frequency and decreases with the number of words between it and the stimulus word, and that the effect of the context as a whole increases with the proportion of words having the same first order associative effects. The data were consistent with the assumption that these effects were algebraically additive. The results of the Howes & Osgood experiment explain Buchwald's (26) observation that in a multiple-choice form of the association test the frequencies of the associations differed according to the order in which the response alternatives were presented.

The effectiveness of associative strength as compared with the effectiveness of semantic connection (synonymy or antonymy) in facilitating paired-associate learning was studied by Bastian (6) and Ryan (129). Both found associative strength to be the more powerful factor. Further investigation by Cofer & Yarczower (41), however, showed that synonymy was effective only through associative strength—that there was no facilitation with pairs that were synonymous but not associated to some degree.

Noble's *m*—a scaling of words according to the number of associations

each elicits in a given period of time—has been reported to be an effective variable in a number of studies; for example, Kristofferson (77) found a substantial correlation between the *m* of a word and the probability of correct recognition in tachistoscopic presentation. Noble & McNeely (111) found the *m* of words to be a positive factor in paired-associate learning.

In accord with the idea that word associations reflect language experience, the fact that words differ in the number of associations they elicit would seem to stem from the fact that words differ with regard to the variety of contexts in which they occur. Diversity of occurrence—as we might term this phenomenon—is certainly correlated with frequency of occurrence, but it is not perfect correlation, as can be seen from the next two experiments. Lambert (80), using the method of continuous free association, found in both English and French that concrete nouns elicited more associations than either adjectives or abstract nouns. Stimulus words for all three classes were matched for frequency of occurrence. Similarly, Laffal (79) found the range of response diversity to be quite large—from 2 to 49 different associations out of 80 responses—even when the word frequency of the stimuli was controlled within narrow limits (10 to 25 occurrences per million). If diversity of occurrence of a word—as approximated, say, by the number of its different dictionary meanings—is indeed *not* highly correlated with frequency of occurrence, then psycholinguistics may find it to be a very useful measure.

RECOGNITION OF SPEECH SOUNDS

A solid body of data accumulated over the years by phoneticians and acousticians plus the development of equipment capable not only of analyzing but of synthesizing speech has brought research in the recognition of speech sounds to the point where mechanical speech recognition (and perhaps the voice typewriter) are in the offing. The speech synthesizer has been responsible for most recent advances. It permits the experimenter to make numerous variants of the same speech sound equally distributed along some dimension. From the responses of his listeners, the experimenter is then able to determine the probability of correct identification as a function of the specific variable in which he is interested. A very informative account of the research done along these lines was prepared by Liberman (84). The objection that the responses to synthetic speech might differ from the responses to real speech has been met by the use of tape-splicing, by which Malécot (91, 92) has confirmed some of the findings of the purely synthetic technique. Another approach to the study of speech recognition is the confusion experiment. Here, the sounds are presented randomly just above auditory threshold, through filters, or in noise. Analysis of the listeners' responses yields the probability with which each sound will be confused with every other sound. This technique was employed in the study of consonants by Tolhurst (150) and Miller & Nicely (103). Pickett has used it for vowels (119) as well as for consonant clusters (120).

The general results of studies using all these techniques may be summed up as follows: (a) Cues for sound recognition are found primarily in the formants (the two or three frequencies containing the greatest concentrations of energy), in the formant transitions between consonants and vowels, in the frequencies of the bursts in the release of stop consonants, and in the durational aspects of certain sounds. In regard to the effect of duration, experiments by Lisker (87) on stops and Denes (45) on sibilants are of interest. (b) The cues serve to identify particular articulatory features of sounds like voicing, nasality, and place of articulation but do not distinguish some particular sound from all the other sounds in the language. This is most clearly pointed out by Miller & Nicely (103) and supports Jakobson & Halle's (72) view of distinctive features. Thus, if a particular cue is masked by noise or filtered out, the remaining cues tend to restrict the listeners' responses to the set of sounds sharing the features which remain. For example, if the burst of /t/ is filtered out, the listeners' responses are generally either /k/, /p/, or /t/ since the remaining cues indicate a voiceless stop. (c) There is considerable redundancy with regard to cues. This is true not only for consonants and vowels but also for stress. Fry (51) found that intensity, duration, and fundamental frequency may each serve as a cue for the perception of stress. (d) Not all cues are equally effective. Thus Fry pointed out that duration is a more powerful cue for stress than intensity. Interestingly enough, Selezneva's (133) findings indicate that duration is the more powerful in Russian, too. (e) Certain differences between sounds seem to have more cues than others. For example, the voiced-voiceless difference between /b/ and /p/ is cued by differences in the first formant transition, the frequency of the burst, duration of closure, and sometimes the presence or absence of aspiration. In contrast, only two cues have been discovered for the place-of-articulation difference between /p/ and /t/: differences in the second formant transition and in the frequency of the burst. In line with this, Miller & Nicely (103) found the voiced-voiceless difference was recognized much better than the place-of-articulation difference.

The psychological reality of the phoneme.—Despite the almost infinite physical variety of sounds in any language, linguists have been able to group them into a small number of classes called phonemes. The concept of the "psychological reality of the phoneme"—which has nothing to do with the linguist's formal operations—maintains that sounds belonging to the same phoneme are not perceived as different by naïve speakers while sounds belonging to different phonemes are perceived as different and are used to differentiate one word from another. An experiment carried out by Liberman *et al.* (85) substantiates this point of view. They presented a series of sounds proceeding in equal steps from a long rising second-formant transition to a long descending transition. When listeners were asked to identify these sounds as /b/, /d/, or /g/, the shifts in identification were found to be very abrupt. The steps where the shifts occurred were considered phoneme bound-

aries, and an experiment of the ABX-type was then carried out. Three stimuli (steps in the variation of the second-formant transition) were presented: A, B, and X. X was identical with A or B. The listener was to say whether X was the same as A or B. It was found that discrimination was better at the phoneme boundary than in the middle of the phoneme range. The investigators concluded that "with acoustic differences equal, subjects discriminated better between speech sounds to which they habitually attach different phonemic labels than they did between sounds which they normally put in the same phoneme class." Brown (17) reported a pair of experiments, one confirming the failure to discriminate nonphonemic differences and the other illustrating a condition under which nonphonemic differences are discriminated. The experimenter exposed in random order (one at a time) eight color chips representing four different colors, orally naming each color with a nonsense word—ma, ma:, mo, mo: (: indicates lengthened vowel). The subject was to group the chips according to the names indicated by the experimenter. In the first experiment the sensory distances between the colors were equal, and subjects, failing to discriminate the nonphonemic differences in vowel length, divided the colors into two classes (ma, ma:/mo, mo:). In the second experiment, the sensory distances between the colors represented by ma and ma: and by mo and mo: were much greater than between ma: and mo:. The greater distances served to call attention to the nonphonemic differences in vowel length, and most subjects correctly distinguished four classes.

Other factors in speech recognition.—The studies reviewed up to this point have dealt with speech recognition in terms of the acoustic features of the sounds of speech themselves. A number of investigations have sought to determine the contribution to recognition made by other factors. For example, while it is known that under conditions of auditory clarity the listener gains very little by watching the speaker's face, listening to speech in noise is a different matter. Sumby & Pollack (144) clearly demonstrated that the advantage of listening and seeing over listening alone increases greatly as the speech-to-noise ratio becomes less favorable. They pointed out, however, that the visual informational contribution relative to the maximum contribution is approximately constant over all speech-to-noise ratios. O'Neill (112) investigated visual contribution as a function of the kind of linguistic material. He found that the visual contribution decreased in this order: consonants, vowels, words, phrases. This follows from the fact that the ordering represents the hierarchy of increasing auditory contribution.

Howes (66) and Rosenzweig & Postman (125) reported that when word frequency is controlled, recognition in noise is a function of word length. While on first consideration one might ascribe the effect of length to the greater energy of longer words, Howes interpreted this effect in terms of probability of occurrence: the sum of the frequencies (according to the Thorndike-Lorge count) of all words of X length decreases as x increases.

Therefore, given two words of the same frequency but of different lengths, and assuming that the subject identifies the lengths, the longer word has the greater probability of recognition.

LABELLING

The effect of affixing names to some object on performance involving that object has been studied surprisingly little considering its potential importance. The few experiments reported in recent years suggest that the effectiveness of a label depends not so much upon whether it is appropriate for the object as upon its appropriateness for the task in which the object is employed.

Liublinskaya (88) reported that children shown a butterfly wing and later asked to identify it in a large group of wings were able to perform better if they were given labels such as "spots," "stripes," and "nets" with which to characterize the wings. Braun & Bendig (15) found that the learning of a perceptual-motor task was facilitated by irrelevant word labels and even by nonsense syllables. The association value—the number of associates connected with the word or nonsense syllable—had no effect on learning. Campbell & Freeman (28) had subjects view pairs of pictures under three conditions of verbal labelling: no labelling, a descriptive label under each individual picture, and a descriptive phrase under the pair of pictures denoting some structural characteristic common to both. In the task of rematching the pairs from a scrambled set, subjects who had seen the pairs with a common descriptive label did better than the subjects in either of the other groups. The group which had viewed the pictures with a separate label under each picture did more poorly than the group which had seen the pictures without any labels at all. The authors concluded that language may act to facilitate or to interfere with perceptual learning according to whether it directs the subject's attention to the similarity of the stimuli or directs his attention away from it. Herman, Lawless & Marshall (63), using the Carmichael-Hogan-Walter materials, found that the influence of labelling diminishes when the subject is aware that he will be required to reproduce the forms and when he is allowed to view the forms for a period of time sufficient for him to attend to their details.

MEASURES OF MEANING

A great amount of research effort has gone into the development of the semantic differential and into attempts to determine its applicability in a wide variety of problem areas. In a relatively short period of time, it was employed in several cross-cultural investigations, notably those of Kumata & Schramm (78), Prothro & Keehn (123), and Triandis & Osgood (152); in at least two clinical investigations—Osgood & Luria's (115) study of "Eve White" and Semans' (134) study of lobotomized patients. It was used by Lambert, Havelka & Crosby (82) to study bilingualism, by Staats & Staats (141) to show that nonsense syllables can be conditioned to the

common connotative meaning of a number of different words, by Solley & Messick (139) to measure the extent to which subjects had been influenced by differences in the frequency of word combinations presented during a probability-learning task, by Lipton & Blanton (86) to demonstrate changes in experimentally-induced meaning brought about by the association of nonsense syllables and geometric designs, and by McMurray (95) to exhibit the existence of a synesthesia-like correspondence between words and pictorial designs. A complete exposition of the technique became available in Osgood, Suci & Tannenbaum's (117) *The Measurement of Meaning*. Jenkins, Russell & Suci (74) published an atlas containing the mean values for 360 words on 20 scales. Alone or in conjunction with Jenkins & Russell's (73) table of semantic distances, the atlas provides ready-made material for further experimentation.

Although studies employing the semantic differential clearly dominated the field, a number of studies involving unidimensional scaling also reported interesting results. Cliff (38) had subjects rate all possible combinations of 9 adverbs of degree with 15 evaluative adjectives (e.g., "very good," "quite contemptible") on an 11-interval favorable-unfavorable continuum and found that the adverbs combined multiplicatively with the adjectives to produce a scale of equal degrees of increasing intensity. Jones & Thurstone (75) employed a nine-interval continuum to obtain the semantic judgments of subjects on descriptive words and phrases such as "despise," "very bad," and "like fairly well." They were able to establish an equal-interval scale having high reliability and permitting the unambiguous location of most of the words and phrases on the standard units of the scale. Fine & Haggard (48) made use of this same scale, however, to demonstrate that the locations of the same words and phrases change when the context is made more specific (e.g., when "very bad" was rated in the context "roast beef" or opposed to the context "foods").

THE WHORFIAN HYPOTHESIS

In its boldest form, this hypothesis maintains that differences in linguistic habit cause differences in nonlinguistic behavior. Though this hypothesis has evoked great interest in the last few years, the number of relevant studies that have appeared so far is quite small and the total evidence is ambiguous. The groundwork for recent efforts to test Whorf's hypothesis experimentally was laid by Brown & Lenneberg (20), who showed that the recognition of colors was related to their codability—i.e., to the shortness of their names, to the speed and consistency with which they are named, and most important, to the agreement among subjects in naming them. Flavell (49) tested the effect of the noun-verb opposition in English, hypothesizing that a picture labelled with a verb would be perceived as more active than the same picture labelled with a noun. This hypothesis was not confirmed. Carroll & Casagrande (32) report on two experiments carried out under the Southwest Project in Comparative Psycholinguistics, a project

designed primarily to test the Whorfian hypothesis. In one experiment, English-speaking and Hopi-speaking subjects were asked to select which two of a set of three pictures went together. For example, one set consisted of a picture of woman closing the lid of a box, a picture of a woman placing a dust cover over an object, and a picture of a woman placing a cover on a wicker basket. It was hypothesized that English-speaking subjects would be likely to classify the second and third pictures as belonging together, since the first picture represents closing something while the other two represent placing a cover on something. In Hopi, there is one verb used for "placing covers on boxes," "closing lids," and the like, and another verb meaning "to cover something as a protection against dust or damage." Therefore, it was hypothesized that Hopi-speaking subjects would be likely to classify the first and third pictures as belonging together, since they both represent "closing lids" while the second represents covering something as a protective measure. Differences were found in the hypothesized direction but were not statistically significant.

The second experiment compared the sorting behavior of three groups of Navaho children: predominantly Navaho-speaking, predominantly English-speaking, and evenly practiced in both languages. Since the Navaho language requires different forms of verbs of handling according to the shape of the object handled, it was hypothesized that in pairing objects, the predominantly Navaho-speaking children would make more pairings according to shape (rather than according to color or size) than the other two groups. The hypothesis was confirmed. However, study of the sorting behavior of white American children of the upper middle class revealed that they made even more pairings according to shape than the predominantly Navaho-speaking children. The authors concluded that while form discrimination may be stimulated by the requirements of a particular language, it may also be produced by cultural activities, e.g., playing with toys involving fitting of forms and shapes.

There are several studies which have employed the semantic differential with different linguistic groups. For example: Kumata & Schramm (78) compared the reactions of American students and bilingual Japanese and Korean students to politically charged words; Prothro & Keehn (123) investigated the reactions of English-speaking Arab students to trait names descriptive of national-character stereotypes; and Triandis & Osgood (152) analyzed the reactions of monolingual Greek and American students to common English words (e.g., "female," "family," "justice," "snow") and their Greek equivalents. All studies reported considerable cross-cultural similarity in judgments of meaning.

UNIVERSAL PHONETIC SYMBOLISM

Essentially, the hypothesis of universal phonetic symbolism maintains that historically unrelated languages employ analogous phonemic contrasts in words whose referents differ in some quality such as size, length, or color.

The underlying rationale employs random observations about the physical world (e.g., small objects emit high sounds, large objects low sounds) or observations about the tendency to gesture with the tongue or lips, or the tendency to associate colors with certain tones. Many of the studies relevant to this hypothesis have been reviewed in detail by Brown (19). Recently, Brown, Black & Horowitz (21) revived the notion of a universal phonetic symbolism by repeating, with better controls, earlier experiments in which it was shown that subjects were able to match English and unfamiliar foreign language words for meaning with a greater-than-chance probability. This sort of evidence was contested in two studies, however. Maltzman, Morrisett & Brooks (93) tested the findings of Brown, Black & Horowitz by having English-speaking subjects match Japanese words to their Croatian equivalents as well as having them match both the Japanese and Croatian words to their English equivalents. They were able to obtain better-than-chance matching only where English was involved. However, their results are rendered suspect by the fact that the subjects never heard the foreign words pronounced and by the fact that they were given the peculiar instruction to "avoid terminological schemes such as associating sounds, letters, length of words, etc." Brackbill & Little (14) had English-speaking subjects match all combinations of English, Japanese, Chinese, and Hebrew word pairs for meaning. The words were presented either auditorily, visually, or audio-visually. These authors found that subjects could do better-than-chance matching in only half the language combinations (English-Hebrew, Chinese-Japanese, and Hebrew-Japanese).

LANGUAGE LEARNING

Relatively little substantial research on language learning appeared during the period covered by this review. The following studies, however, seemed to be of special interest.

Brown (18) suggested that the child's vocabulary reflects primarily the naming behavior of adults, which, in turn, follows the brevity-frequency principle and also the principle that of the many names a referent may properly possess, the one that most usefully differentiates it from other things will be most often employed.

A study by Lenneberg (83) suggests that the task faced by the child in learning a language is considerably different from the usual adult language-learning task, where the classifications of referents may require only a shift in labelling or acquisition of classification schemes that are parallel to already conceptualized schemes. To the child, language learning involves the acquisition of classification schemes where dissimilar stimuli are sometimes given the same name and where similar stimuli are sometimes given different names. Lenneberg presented adult subjects with an analogous situation by confronting them with the task of learning color classification schemes that differed from the color classifications of English. Specifically, he varied the frequency with which different nonsense names were applied to

a given range of stimulus colors, thus increasing or decreasing the probability that a given hue would—in this strange language—be called by one name or another. Attainment of the color-classification schemes was found to be regulated by the shape of the frequency distributions of the color names over the color continuum, a scheme with greatly overlapping distributions being more difficult to learn than one with less overlap or one paralleling the distributions of English.

Lambert, Havelka & Crosby (82) found that bilinguals who had learned both languages in an environment where words of both languages were used interchangeably exhibited greater associative interference than bilinguals who had learned both languages in completely different cultural contexts. They related their findings to Ervin & Osgood's (46) theory of compound and co-ordinate bilingualism.

In the area of second-language learning, Lambert (81) attempted to differentiate two levels of acquisition by employing Noble's *m*-technique with undergraduate and graduate American students majoring in French. Subjects were given both English and French stimulus words and were required to associate continuously to each word in either English or French or both. The graduate students resembled native French speakers in their response hierarchies more than the undergraduates did, but there was still a very clear difference between the graduate students and the native French. Carroll (30) attempted to predict language-learning aptitude by means of an extensive battery of tests administered to subjects prior to a short course in Mandarin Chinese. Factor analysis of the test scores yielded seven major factors, six of which proved to be significantly related to the ability to learn a second language. Tests heavily loaded with factors called linguistic interest, associative memory, and inductive language-learning ability were found to be the best predictors.

LANGUAGE DISTURBANCES

The research in the area of language disturbances has been quite unsatisfying from a psycholinguistic point of view. This is not to make light of the difficulties of working with abnormals—where the experimental method has limited application and where the psycholinguist is, for the most part, faced with the time-consuming and laborious task of minute analysis of utterances. Still, the fact remains that we have little by way of systematic knowledge of disturbed language and that very little more has accrued during the past five years.

Even so, a few studies of an experimental nature have appeared in recent years which are quite provocative. Starkweather (142), observing a frequent incongruence in the verbal and vocal aspects of speech in hypertensive individuals, removed the verbal component from their speech recordings by electronic filtering and presented both the filtered and nonfiltered versions to a group of judges. He found that his judges could distinguish the speech of hypertensives from the speech of normal subjects more successfully on the

basis of vocal aspect alone. Spilka (140) reported that increased variation in vocal intensity during delayed speech feedback is positively related to poor general adjustment and paranoid behavioral tendencies while decreased variation is positively related to schizoid tendencies and isolating modes of adjustment. Winchester & Hartman (155) investigated auditory dedifferentiation in aphasic patients by comparing their comprehension through noise and over a clear channel. They found that their subjects understood speech in noise less successfully than normal control subjects did, even though there was no difference between the two groups in the clear-channel condition. Possibly some of the learning and recognition tasks with materials of known probabilities (described in the section on the Probability of Language Segments) might also be of some use in experimentation with abnormals, provided the experimenter has some confidence that his subjects understand the task.

Turning to analytic studies, one finds the usual measures: counts of grammatical classes, the type-token ratio, verb-adjective ratio, and so on. A few studies employing these traditional measures are of interest. Lorenz & Cobb (89) computed the frequencies of words and grammatical classes in 1000-word samples of the speech of two psychotic and two neurotic groups. Their data showed differences among all four groups but also showed that all four groups differed from normal. Smith (138) studied the written productions of one woman over a 40-year period of her life, tracing the changes in word and grammatical-class frequencies, word length, and vocabulary diversity occurring before and after the onset of senile dementia. Jaffe (70) used the type-token ratio in an unusual way. He applied it to samples of 25, 50, or 100 consecutive words occurring in an interview without separating out the speakers. Jaffe reasoned that any sizeable variation in the type-token ratio would indicate something of the course of the conversation at that point, e.g., a high type-token ratio might indicate a flight of ideas or distractability while a low ratio might indicate a request for orientation in a rambling narrative. Adhering to a traditional interpretation of aphasia, Luria (90) discussed anew the aphasic correlates of site of lesion. Temporal-zone lesions tend to result in a loss of phonemic opposition, so that, for example, "neck" and "net" come to sound the same. This, in turn, leads to a failure in the capacity to make meaningful differentiations among phonemically similar words and results in the disintegration of the basic semantic structure of the language. The degree to which site of lesion is related to language impairment is illustrated by his figures for parieto-occipital as opposed to fronto-temporal lesions. Loss in the comprehension of syntactical structure occurred in 60 per cent of his subjects with parieto-temporal lesions, but in none of his fronto-temporal lesion subjects. Loss in the ability to repeat a series of words occurred in 95 per cent of his subjects with fronto-temporal lesions, but in only 16 per cent of his parieto-temporal lesion subjects.

In contrast to the important role played by the Thorndike-Lorge count in other psycholinguistic research, it is rarely employed in the study of

abnormal language. Wepman *et al.* (154) used it to great advantage in their study of anomia, a type of aphasia in which the salient feature is considered to be the loss of nouns. The question taken up by Wepman and his associates was whether nouns are lost because of the nature of their function or because low frequency words are lost and a large proportion of such words are nouns. The analysis of the data clearly supported the latter view—only the more frequent words of all classes were retained. In this connection it is interesting to observe that Beyn (11), investigating the language of Russian patients suffering from sensory aphasia, found that at the conclusion of therapy the proportion of nouns in their speech doubled while the proportion of pronouns (words of very frequent occurrence) was halved. Jakobson (71) proposed a view which ties together the disintegration of language patterns in aphasic disturbances and the two fundamental processes involved in normal language usage: the selection of particular linguistic units from the total number of units available, and the combination of those units into larger and more complex patterns. All aphasic disturbances are thus divided into two types, according to which of these two processes has been affected. In "similarity disorder," in which the selection process is affected, speech fails where the contextual constraint is weak, i.e., where the aphasic is required to initiate an utterance that is not a response to a preceding utterance or to a visual stimulus. It is characterized, for example, by the conversion of free forms into bound forms (e.g., the patient never uses "knife" alone but says "bread-knife" or "knife and fork") or by the omission of the subject of the sentence or the substitution of a very general noun for a special one. In "contiguity disorder," speech fails where words have to be organized into a sentence and results in a mere "word heap." It is characterized, for example, by the omission of function words and the absence of grammatical inflection.

Matarazzo, Saslow & Matarazzo (94) suggested using the interaction chronograph as a means of studying interview behavior in terms of the number of speech actions initiated by each person, the duration times of speech and silences, the frequency of interruption on the part of each speaker, and of automatically manipulating these and other tabulations to produce whatever measures of speech interaction are desired. Goldman-Eisler (54) took extensive recordings of speech rate and speech breathing activities during the continuous discourse of both normal and neurotic subjects. She reports, for example, that speech rate, rate of respiration, and the number of syllables per respiration are correlates of tension and affect. Of special interest is McQuown's (96) use of fine phonetic analysis of a patient's speech to describe not only the speech sounds but the contour and voice qualities as well. The essentials of this kind of phonetic analysis are given by Trager (151). Trager distinguishes between voice qualities and vocalizations. Voice qualities are the over-all characteristics of the speech (pitch range, rasp or openness, sharp or smooth transitions in pitch, articulation control, etc.), and vocalizations are actual identifiable sounds or aspects of sounds. There are three types of

vocalizations: vocal characterizers (laughing, crying, yelling, whispering, moaning, groaning, etc.); vocal qualifiers (intensity, pitch, extent of drawl or clipping); and voice segregates ("uh-uh" for negation, "uh-huh" for affirmation, the "uh" of hesitation, "sh").

There has been a long-standing interest in developing methods for analyzing the content of psychiatric interviews. Although a sizeable number of techniques for dividing and coding interview material have been suggested, nearly all of them are in terms of psychotherapeutically oriented descriptive categories, "meaningful" units, or coarse linguistic units. Recent developments in linguistics, however, hold the promise of filling the need for more refined methods of analyzing content. One of these is the concept of discourse analysis developed by Harris (59). Discourse analysis is a technique for the linguistic analysis of small samples of connected language, e.g., conversations, essays, etc. The discourse is put through a process of transformation (described below) which maximizes the number of recurrent phrases. Words or phrases occurring before or after recurrences of the same phrase are grouped into the same equivalence class. From the point of view of psycholinguistics, Harris' technique provides the kind of content analysis which has the virtue that the classes emerge in the course of the analysis itself rather than from some *a priori* system of classification.

According to the concept of transformation developed by Harris (60) and Chomsky (36), if two constructions are satisfied by the same words or morphemes, the constructions are transforms of each other. For example, the constructions "the (noun) (verb) (noun)" and "the (noun)'s (verb)ing (noun)" are both satisfied by "foreman," "put up," "lists": "the foreman put up lists" and "the foreman's putting up lists." In discourse analysis, a phrase may be replaced by its transform to produce a greater homogeneity of form in the text. Chomsky (35) suggests that the study of transformations may also shed some light on ambiguity. He points out that "flying planes" is ambiguous in the sentence "Flying planes can be dangerous," since it is a transformation of either "planes fly" or "they fly planes."

LANGUAGE STATISTICS

While there may be a question of whether language statistics are properly part of the subject matter of psycholinguistics, it is clear that they provide psycholinguistics with a basic tool of investigation. They serve as independent variables, as a means of controlling linguistic variation, and as a base for measuring deviant features in particular language samples. In some instances, simple relationships between sets of statistical data direct attention to potentially profitable lines of further inquiry. In Berry's (10) study, for example, the discovery of an inverse relationship between emphatic word stress and word frequency suggested that those words most important to the intelligibility of the sentence are the ones most strongly emphasized in speech. Unfortunately, the compilation of language statistics presents formidable difficulties, not the least of which is an ignorance of what is worth

counting. Statistics presently available are based, for the most part, on relatively small samples and gross classes. There is reason to believe, however, that the growth of interest in mechanical translation and in the mechanization of speech recognition and information retrieval will result in the gathering of statistical data involving finer classifications and larger samples.

Before particular studies are taken up, special mention ought to be made of Herdan's *Language as Choice and Chance* (61), a book devoted entirely to statistical phenomena in a wide variety of languages. It contains a great deal of information otherwise not readily available. Unfortunately, it is marred by a number of errors and must be used cautiously. It is to be hoped that Professor Herdan will soon revise it and, at the same time, add some of the more recent contributions to the field.

Most recent research in language statistics has been concerned with the word. There have been, however, a few studies on phonemes and letters independent of direct consideration of the word. Belevitch (8) suggested a method for predicting the relative frequencies of occurrence of the phonemes of any language. His technique involves maximizing the amount of information per unit cost, where cost is, interestingly enough, reckoned in terms of the number of distinctive features characterizing the phonemes. The probabilities for the phonemes of Russian predicted by Belevitch's method were found to be in good agreement with the experimental probabilities. Herdan (62), classifying phonemes by manner (voiced-voiceless) and by place of articulation (labial, dental, etc.), compared their frequencies of occurrence in a random sample of words drawn from the dictionary with their frequencies of occurrence in a random sample of words drawn from continuous text. He found the two distributions to be very similar and concluded that the phoneme distribution in speech is a random sample of the phoneme distribution in dictionary material. Black (12) studied the frequency of occurrence of speech sounds in one- and two-syllable isolated words. He obtained probability-of-occurrence figures for sounds at different positions in the word and for pairs of sounds occurring together. An important finding—although not an unexpected one—was that the average information per sound decreases with the length of the word. Saporta (131) and Carroll (31) offered evidence that clusters of highly similar or highly dissimilar consonants tend to occur with lower relative frequency than chance would allow.

Turning to studies on words, a very useful listing of all the monosyllables in American English has been compiled by Moser, Dreher & Oyer (109). Statistical data supplied include the number of words beginning, ending, or beginning and ending with given consonants, the number of words containing clusters of two or more consonants, the number of words of each length, and the number of words having each consonant-vowel pattern.

The relationship between rank (according to frequency) and frequency, pointed out decades ago by Estoup, Condon, and Zipf, is still being investigated and exploited with considerable profit. Mandelbrot (106) recently hypothesized that the rank-frequency relationship results from the fact that

the space symbol (i.e., the space between words) occurs randomly, with the consequence that short strings of letters occur more frequently than long strings. The longer the strings the greater the variety of words. Thus, fewer different short words share among themselves a great probability while a much greater variety of long words share only a small probability. Mandelbrot's hypothesis, then, accounts for the inverse relationship between length and frequency. Considering that ranking according to decreasing length will approximate ranking according to increasing frequency, his reasoning ultimately proposes an explanation of the rank-frequency relationship. Miller & Newman (102) tested Mandelbrot's hypothesis in two ways. First, they tested the consequence of his reasoning that $RF = rf$, where R is the average rank of a word with respect to increasing length, F is the average frequency of the given length, r is the rank with respect to frequency, and f is the frequency of words with the given rank. Second, they tested this approximation with strings of letters between successive occurrences of the letter "e." They chose "e" since, by Mandelbrot's reasoning, any letter might serve as the boundary marker just as well as the space symbol. In both instances, the results confirmed the approximation. In a consequent study, however, Miller, Newman & Friedman (106) found that Mandelbrot's view of word length as the primary factor in the rank-frequency relationship was not altogether accurate. On considering function words (e.g., articles, prepositions, conjunctions) and content words (nouns, verbs, adjectives, and adverbs) independently, they found that the length-frequency relationship held for function words but not for content words, so that for content words the RF did not approximate rf . They concluded that the relationship between rank and frequency cannot be explained by mathematical reasoning alone, that further linguistic investigation is required. It should be noted that Miller, Newman & Friedman ran their test on the printed language. It would seem advisable to test the length-frequency relationship in the spoken language as well—and possibly with a larger sample.

Fucks (52), comparing data from such diverse languages as English, Arabic, Japanese, Latin, and Turkish, found that information (entropy) in word length in these languages increased as the average length of words increased. Thus English, with a mean word length of 1.35 syllables, had .367 bits of word-length information, while Turkish, with a mean word length of 2.45 syllables, had .629 bits of word-length information. The relationship between the mean word length and the probability distribution of the various lengths was close enough to permit Fucks to set up an equation to estimate the probability of a given word length on the basis of the mean word length for the language. Bell & Ross (9) computed the negative entropy of Welsh words of various lengths in terms of number of letters. Negative entropy was computed as the difference between maximum information and the actual information for the given length. In Welsh, they found the lowest negative entropy in two-letter words, while in English the lowest negative entropy occurs in three-letter words.

Since the type-token ratio (the number of different words divided by the total number of words in the sample) has been shown to be dependent upon sample size, the usefulness of the measure is somewhat curtailed. Guiraud (56), however, proposed two measures which, he said, are approximately independent of sample size. The first is a simple modification of the type-token ratio: the number of different words in the sample divided by the square root of twice the number of words in the sample. The second is a measure of vocabulary concentration, and is equal to the sum of the frequencies of the 50 most frequent words in the sample divided by twice the number of words in the sample. Another measure of diversity independent of sample size was suggested by Herdan (61): the standard error of the mean divided by the mean, where by "mean" is meant the mean number of occurrences for each different word in the sample. The data presented by Herdan seem to support his contention that this measure is indeed independent of sample size—at least in the case of the sizes of his samples, which are all 1000 or larger. It would be helpful to know whether the measure holds up for smaller samples.

There has been considerable interest in developing a method for determining the number of words in the lexicon from which the words of the sample were taken. Guiraud (56) suggested an approximation:

$$L = 2N \left[\frac{2V_1}{V} \right]^\alpha,$$

where N is the number of words in the sample, V_1 is the number of different words occurring only once, V is the total number of different words in the sample, and α is a constant reflecting the frequency distribution of words in the lexicon, L . More precisely,

$$\alpha = \frac{1}{\text{slope of } V - \text{slope of } V_1},$$

the slopes obtained by taking several samples of different sizes.

Very little statistical work has appeared on the structure of sentences. Thomas (148) conducted a preliminary study of grammatical sequences on a sample of 550 sentences, using an electronic computer. Although only six grammatical classes were recognized, new patterns were still coming in at the rate of 20 patterns per 50 sentences at the end of his sample. Aborn & Rubenstein (1) studied the frequencies of grammatical classes as a function of position in the sentence in sentences 6, 11, and 25 words long. The distributions were strikingly similar in all three lengths, with little variation among sentence positions except at the initial and final positions and, to some extent, at the immediately adjoining positions. The initial and final positions also showed the greatest inequalities in frequency of occurrence among the various classes.

BOOKS

Among those works which have not been cited in the review but which are relevant to the problems of psycholinguistics are: Apostel, Mandelbrot

& Morf's (4) *Logique, langage et théorie de l'information*, which contains a relatively clear exposition of Mandelbrot's statistical theories; Broadbent's (16) *Perception and Communication*; Cherry's (34) *On Human Communication*, which reviews a good deal of the research in psycholinguistics and is especially strong in language acoustics; Osgood & Sebeok's (116) *Psycholinguistics*; and Skinner's (137) *Verbal Behavior*. For a linguist's view of Skinner's work, see Chomsky (37).

LITERATURE CITED

1. Aborn, M., and Rubenstein, H. Word-class distribution in sentences of fixed length. *Language*, **32**, 666-74 (1956)
2. Aborn, M., and Rubenstein, H. Perception of contextually dependent word-probabilities. *Am. J. Psychol.*, **71**, 420-22 (1958)
3. Adelson, M., Muckler, F. A., and Williams, A. C., Jr. Verbal learning and message variables related to amount of information. In *Information Theory in Psychology*, pp. 291-99 (Quastler, H., Ed., The Free Press, Glencoe, Ill., 436 pp., 1955)
4. Apostel, L., Mandelbrot, B., and Morf, A. *Logique langage et théorie de l'information* (Presses Universitaires de France, Paris, France, 207 pp., 1957)
5. Baker, K. E., and Feldman, H. Threshold-luminance for recognition in relation to frequency of prior exposure. *Am. J. Psychol.*, **69**, 278-80 (1956)
6. Bastian, J. R. *Response Chaining in Verbal Transfer: Studies on the Role of Language in Behavior*, N8-onr-66216, Tech. Rept. No. 13 (University of Minnesota, Minneapolis, Minn., 1957)
7. Battig, W. F. Some factors affecting performance on a word-formation problem. *J. Exptl. Psychol.*, **54**, 96-104 (1957)
8. Belevitch, V. Théorie de l'information et statistique linguistique (Information theory and language statistics). *Bull. acad. roy. Belg. Classe Sci., 5th Sér.*, **42**, 419-36 (1956). Reviewed by ET in *Behavioral Sci.*, **2**, 164 (1957)
9. Bell, D. A., and Ross, A. S. C. Negative entropy of Welsh words. In *Information Theory, Third London Symposium, 1955*, Chap. 16, 149-53 (Cherry, C., Ed., Academic Press, Inc., New York, N. Y., 401 pp., 1956)
10. Berry, J. Some statistical aspects of conversational speech. In *Communication Theory*, Chap. 28, 392-401 (Jackson, W., Ed., Butterworths Sci. Publ., London, England, 532 pp., 1954)
11. Beyn, E. S. O nekotorykh osobennostiakh smyslovoi struktury slova i grammaticheskogo stroia rechi pri sensornoi afazii (Some characteristics of the semantic structure of the word and of the grammatical organization of speech in sensory aphasia) *Voprosy Psikhologii*, No. 4, 90-101 (1957)
12. Black, J. W. The information of sounds and phonetic diagrams of one- and two-syllable words. *J. Speech Hearing Disorders*, **19**, 397-411 (1954)
13. Bousfield, W. A., Cohen, B. H., and Whitmarsh, G. A. Associative clustering in the recall of words of different taxonomic frequencies of occurrence. *Psychol. Repts.*, **4**, 39-44 (1958)
14. Brackbill, Y., and Little, K. B. Factors determining the guessing of meanings of foreign words. *J. Abnormal Social Psychol.*, **54**, 312-18 (1957)
15. Braun, H. W., and Bendig, A. W. Supplementary report: Effect of addition of irrelevant verbal cues on perceptual-motor learning. *J. Exptl. Psychol.*, **55**, 301-2 (1958)

16. Broadbent, D. E., *Perception and Communication* (Pergamon Press, New York, N. Y., 338 pp., 1958)
17. Brown, R. W. Language and categories. In *A Study of Thinking*, Appendix, 247-312 (Bruner, J. S., Goodnow, J. J., and Austin, G. A., Eds., John Wiley & Sons, Inc., New York, N. Y., 330 pp., 1956)
18. Brown, R. W. How shall a thing be called? *Psychol. Rev.*, **65**, 14-21 (1958)
19. Brown, R. W. *Words and Things* (The Free Press, Glencoe, Ill., 398 pp., 1958)
20. Brown, R. W., and Lenneberg, E. H. A study in language and cognition. *J. Abnormal Social Psychol.*, **49**, 454-62 (1954)
21. Brown, R. W., Black, A. H., and Horowitz, A. E. Phonetic symbolism in natural languages. *J. Abnormal Social Psychol.*, **50**, 388-93 (1955)
22. Bruce, D. J. Effects of context upon intelligibility of heard speech. In *Information Theory, Third London Symposium, 1955*, Chap. 26, 245-52 (Cherry, C., Ed., Academic Press, Inc., New York, N. Y., 401 pp., 1956)
23. Bruce, D. J. The effect of listeners' anticipations on the intelligibility of heard speech. *Language and Speech*, **1**, pt. 2, 79-97 (1958)
24. Bruner, J. S., and O'Dowd, D. A note on the informativeness of parts of words. *Language and Speech*, **1**, pt. 2, 98-101 (1958)
25. Bruner, J. S., Miller, G. A., and Zimmerman, C. Discriminative skill and discriminative matching in perceptual recognition. *J. Exptl. Psychol.*, **49**, 187-92 (1955)
26. Buchwald, A. M. The generality of the norms of word-associations. *Am. J. Psychol.*, **70**, 233-37 (1957)
27. Burton, N. G., and Licklider, J. C. R. Long-range constraints in the statistical structure of printed English. *Am. J. Psychol.*, **68**, 650-53 (1955)
28. Campbell, V., and Freeman, J. T. Some functions of experimentally-induced language in perceptual learning. *Perceptual Motor Skills*, **5**, 71-79 (1955)
29. Carlson, V. R. Individual differences in the recall of word-association-test words. *J. Personality*, **23**, 77-87 (1954)
30. Carroll, J. B. A factor analysis of two foreign language aptitude batteries. *J. Gen. Psychol.*, **59**, 3-19 (1958)
31. Carroll, J. B. The assessment of phoneme cluster frequencies. *Language*, **34**, 267-78 (1958)
32. Carroll, J. B., and Casagrande, J. B. The function of language classifications in behavior. In *Readings in Social Psychology*, 3rd ed., pp. 18-31 (Maccoby, E. E., Newcomb, T. M., and Hartley, E. L., Eds., Holt and Co., New York, N. Y., 674 pp., 1958)
33. Chapanis, A. The reconstruction of abbreviated printed messages. *J. Exptl. Psychol.*, **48**, 496-510 (1954)
34. Cherry, C. *On Human Communication* (John Wiley & Sons, New York, N. Y., 333 pp., 1957)
35. Chomsky, N. Logical structures in language. *Am. Document.*, **8**, 284-91 (1957)
36. Chomsky, N. *Syntactic Structures* (Mouton and Co., 's-Gravenhage, The Netherlands, 116 pp., 1957)
37. Chomsky, N. Review of *Verbal Behavior* by B. F. Skinner, in *Language*, **35**, 26-58 (1959)
38. Cliff, N. *The relation of adverb-adjective combinations to their components. N-onr-1858-(15)* (Yale University, New Haven, Conn., 1957)

39. Cofer, C. N., and Ford, T. J. Verbal context and free association-time. *Am. J. Psychol.*, **70**, 606-10 (1957)
40. Cofer, C. N., and Shepp, B. E. Verbal context and perceptual recognition time. *Perceptual Motor Skills*, **7**, 215-18 (1957)
41. Cofer, C. N., and Yarczower, M. Further study of implicit verbal chaining in paired-associate learning. *Psychol. Repts.*, **3**, 453-56 (1957)
42. Daston, P. G. Perception of idiosyncratically familiar words. *Perceptual Motor Skills*, **7**, 3-6 (1957)
43. Deese, J., and Kaufman, R. A. Serial effects in recall of unorganized and sequentially organized verbal material. *J. Exptl. Psychol.*, **54**, 180-87 (1957)
44. DeLucia, J. J., and Stagner, R. Emotional vs. frequency factors in word-recognition time and association time. *J. Personality*, **22**, 299-309 (1954)
45. Denes, P. Effect of duration on the perception of voicing. *J. Acoust. Soc. Am.*, **27**, 761-64 (1955)
46. Ervin, S. M., and Osgood, C. E. Second language learning and bilingualism. In *Psycholinguistics, A Survey of Theory and Research Problems*, pp. 139-46 (Osgood, C. E., and Sebeok, T. A., Eds., *J. Abnormal Social Psychol.*, **49**, Suppl., 203 pp., 1954)
47. Fairbanks, G., and Kodman, F., Jr. Word intelligibility as a function of time compression. *J. Acoust. Soc. Am.*, **29**, 636-41 (1957)
48. Fine, B. J., and Haggard, D. F. Contextual effects in scaling. *J. Appl. Psychol.*, **42**, 247-51 (1958)
49. Flavell, J. H. A test of the Whorfian theory. *Psychol. Repts.*, **4**, 455-62 (1958)
50. Forrest, D. W. Auditory familiarity as a determinant of visual threshold. *Am. J. Psychol.*, **70**, 634-36 (1957)
51. Fry, D. B. Experiments in the perception of stress. *Language and Speech*, **1**, 126-52 (1958)
52. Fucks, W. Mathematical theory of word formation. In *Information Theory, Third London Symposium, 1955*, Chap. 17, 154-70 (Cherry, C., Ed., Academic Press, Inc., New York, N. Y., 401 pp., 1956)
- 52a. Garner, W. R. Symmetric uncertainty analysis and its implications for psychology. *Psychol. Rev.*, **65**, 183-96 (1958)
53. Goldiamond, I., and Hawkins, W. F. Vexiersuch: the log relationship between word-frequency and recognition obtained in the absence of stimulus words. *J. Exptl. Psychol.*, **56**, 457-63 (1958)
54. Goldman-Eisler, F. Speech-breathing activity—a measure of tension and affect during interviews. *Brit. J. Psychol.*, **46**, 53-63 (1955)
55. Goldman-Eisler, F. Speech production and the predictability of words in context. *Quart. J. Exptl. Psychol.*, **10**, 96-106 (1958)
56. Guiraud, P. *Les caractères statistiques du vocabulaire* (Presses Universitaires de France, Paris, France, 116 pp., 1954)
57. Hall, J. F. Learning as a function of word-frequency. *Am. J. Psychol.*, **67**, 138-40 (1954)
58. Hall, J. F., and Ugelow, A. Free association time as a function of word frequency. *Can. J. Psychol.*, **11**, 29-32 (1957)
59. Harris, Z. S. Discourse analysis. *Language*, **28**, 18-23 (1952)
60. Harris, Z. S. Co-occurrence and transformation. *Language*, **33**, 283-340 (1957)

61. Herdan, G. *Language as Choice and Chance* (P. Noordhoff, Ltd., Groningen, The Netherlands, 356 pp., 1956)
62. Herdan, G. The relation between the functional burdening of phonemes and the frequency of occurrence. *Language and Speech*, **1**, 8-13 (1958)
63. Herman, D. T., Lawless, R. H., and Marshall, R. W. Variables in effect of language on the reproduction of visually perceived forms. *Perceptual Motor Skills*, **7**, 171-86 (1957)
64. Howes, D. On the interpretation of word frequency as a variable affecting speed of recognition. *J. Exptl. Psychol.*, **48**, 106-12 (1954)
65. Howes, D. Statistical properties of the word-association experiment. In *Associative Processes in Verbal Behavior: A Report of the Minnesota Conference*, pp. 183-87 (Jenkins, J. J., Ed., University of Minnesota, Minneapolis, Minn., 226 pp., 1955)
66. Howes, D. On the relation between the intelligibility and frequency of occurrence of English words. *J. Acoust. Soc. Am.*, **29**, 296-305 (1957)
67. Howes, D. On the relation between the probability of a word as an association and in general linguistic usage. *J. Abnormal Social Psychol.*, **54**, 75-85 (1957)
68. Howes, D., and Osgood, C. E. On the combination of associative probabilities in linguistic contexts. *Am. J. Psychol.*, **67**, 241-58 (1954)
69. Howes, D., and Solomon, R. L. Visual duration thresholds as a function of word probability. *J. Exptl. Psychol.*, **41**, 401-10 (1951)
70. Jaffe, J. Language of the dyad. *Psychiatry*, **21**, 249-58 (1958)
71. Jakobson, R. Two aspects of language and two types of aphasic disturbances. In *Fundamentals of Language*, Pt. II, 55-82 (Jakobson, R., and Halle, M., Mouton and Co., 's-Gravenhage, The Netherlands, 87 pp., 1956)
72. Jakobson, R., and Halle, M. Phonology and phonetics. In *Fundamentals of Language*, Pt. I, 1-51 (Jakobson, R., and Halle, M., Mouton and Co., 's-Gravenhage, The Netherlands, 87 pp., 1956)
73. Jenkins, J. J., and Russell, W. A. *A Table of Distances for the Semantic Atlas: Studies on the Role of Language in Behavior, N8-onr-66216*, Tech. Rept. No. 20 (University of Minnesota, Minneapolis, Minn., 1958)
74. Jenkins, J. J., Russell, W. A., and Suci, G. J. An atlas of semantic profiles for 360 words. *Am. J. Psychol.*, **71**, 688-99 (1958)
75. Jones, L. V., and Thurstone, L. L. The psychophysics of semantics: an experimental investigation. *J. Appl. Psychol.*, **39**, 31-36 (1955)
76. King-Ellison, P., and Jenkins, J. J. The durational threshold of visual recognition as a function of word-frequency. *Am. J. Psychol.*, **67**, 700-3 (1954)
77. Kristofferson, A. B. Word recognition, meaningfulness, and familiarity. *Perceptual Motor Skills*, **7**, 219-20 (1957)
78. Kumata, H., and Schramm, W. A pilot study of cross-cultural meaning. *Public Opinion Quart.*, **20**, 229-38 (1956)
79. Laffal, J. Response faults in word association as a function of response entropy. *J. Abnormal Social Psychol.*, **50**, 265-70 (1955)
80. Lambert, W. E. Associational fluency as a function of stimulus abstractness. *Can. J. Psychol.*, **9**, 103-6 (1955)
81. Lambert, W. E. Developmental aspects of second-language acquisition. *J. Social Psychol.*, **43**, 83-104 (1956)
82. Lambert, W. E., Havelka, J., and Crosby, C. The influence of language-acquisition contexts on bilingualism. *J. Abnormal Social Psychol.*, **56**, 239-44 (1958)

83. Lenneberg, E. H. A probabilistic approach to language learning. *Behavioral Sci.*, **2**, 1-12 (1957)
84. Liberman, A. M. Some results of research on speech perception. *J. Acoust. Soc. Am.*, **29**, 117-23 (1957)
85. Liberman, A. M., Harris, K. S., Hoffman, H. S., and Griffith, B. C. The discrimination of speech sounds within and across phoneme boundaries. *J. Exptl. Psychol.*, **54**, 358-68 (1957)
86. Lipton, L., and Blanton, R. L. The semantic differential and mediated generalization as measures of meaning. *J. Exptl. Psychol.*, **54**, 431-37 (1957)
87. Lisker, L. Closure duration and intervocalic voiced-voiceless distinction in English. *Language*, **33**, 42-49 (1958)
88. Liublinskaya, A. A. The development of children's speech and thought. In *Psychology in the Soviet Union*, pp. 197-204 (Simon, B., Ed., Stanford University Press, Stanford, Calif., 305 pp., 1957)
89. Lorenz, M., and Cobb, S. Language patterns in psychotic and psychoneurotic subjects. *Arch. Neurol. Psychiat.*, **72**, 665-73 (1954)
90. Luria, A. R. Brain disorders and language analysis. *Language and Speech*, **1**, 14-34 (1958)
91. Malécot, A. Acoustic cues for nasal consonants: an experimental study involving a tape-splicing technique. *Language*, **32**, 274-84 (1956)
92. Malécot, A. The role of releases in the identification of released final stops. *Language*, **34**, 370-80 (1958)
93. Maltzman, I., Morrisett, L., and Brooks, L. O. An investigation of phonetic symbolism. *J. Abnormal Social Psychol.*, **53**, 249-51 (1956)
94. Matarazzo, J. D., Saslow, G. S., and Matarazzo, R. G. The interaction chronograph as an instrument for objective measurement of the interaction patterns during interviews. *J. Psychol.*, **41**, 347-67 (1956)
95. McMurray, G. A. A study of "fittingness" of signs to words by means of the semantic differential. *J. Exptl. Psychol.*, **56**, 310-12 (1958)
96. McQuown, N. A. Linguistic transcription and specification of psychiatric interview materials. *Psychiatry*, **20**, 79-86 (1957)
97. Melville, J. R. Word-length as a factor in differential recognition. *Am. J. Psychol.*, **70**, 316-18 (1957)
98. Miller, G. A. Human memory and the storage of information. *IRE Trans. on Inform. Theory*, IT-2, 129-37 (1956)
99. Miller, G. A. The magical number seven, plus or minus two: some limits on our capacity for processing information. *Psychol. Rev.*, **63**, 81-97 (1956)
100. Miller, G. A. Free recall of redundant strings of letters. *J. Exptl. Psychol.*, **56**, 485-91 (1958)
101. Miller, G. A., and Friedman, E. A. The reconstruction of mutilated English messages. *Inform. and Control*, **1**, 38-55 (1957)
102. Miller, G. A., and Newman, E. B. Tests of a statistical explanation of the rank-frequency relation for words in written English. *Am. J. Psychol.*, **71**, 209-18 (1958)
103. Miller, G. A., and Nicely, P. E. An analysis of perceptual confusions among some English consonants. *J. Acoust. Soc. Am.*, **27**, 338-52 (1955)
104. Miller, G. A., Bruner, J. S., and Postman, L. Familiarity of letter sequences and tachistoscopic identification. *J. Gen. Psychol.*, **50**, 129-39 (1954)
105. Miller, G. A., Heise, G. A., and Lichten, W. The intelligibility of speech as a

- function of the context of the test materials. *J. Exptl. Psychol.*, **41**, 329-35 (1951)
106. Miller, G. A., Newman, E. B., and Friedman, E. A. Length-frequency statistics for written English. *Inform. and Control*, **1**, 370-89 (1958)
107. Miller, I. Perception of nonsense passages in relation to amount of information and speech-to-noise ratio. *J. Exptl. Psychol.*, **53**, 388-93 (1957)
108. Morrison, H. M., and Black, J. W., Prediction of missing words in sentences. *J. Speech Hearing Disorders*, **22**, 236-40 (1957)
109. Moser, H. M., Dreher, J. J., and Oyer, H. J. *One-syllable Words. AFCRC TN 55-56, Tech. Rept. No. 41* (Ohio State University, Columbus, Ohio, 1957)
110. Neisser, U. An experimental distinction between perceptual process and verbal response. *J. Exptl. Psychol.*, **47**, 399-402 (1954)
111. Noble, C. E., and McNeely, D. A. The role of meaningfulness (*m*) in paired-associate verbal learning. *J. Exptl. Psychol.*, **53**, 16-22 (1957)
112. O'Neill, J. J. Contributions of the visual components of oral symbols to speech comprehension. *J. Speech Hearing Disorders*, **19**, 429-39 (1954)
113. O'Neill, J. J. Recognition of intelligibility test materials in context and isolation. *J. Speech Hearing Disorders*, **22**, 87-90 (1957)
114. Osgood, C. E., and Anderson, L. Certain relations among experienced contingencies, associative structure, and contingencies in encoded messages. *Am. J. Psychol.*, **70**, 411-20 (1957)
115. Osgood, C. E., and Luria, Z. A blind analysis of a case of multiple personality using the semantic differential. *J. Abnormal Social Psychol.*, **49**, 579-91 (1954)
116. Osgood, C. E., and Sebeok, T. A., Eds. Psycholinguistics, a survey of theory and research problems. *J. Abnormal Social Psychol.*, **49**, Suppl., 203 pp. (1954)
117. Osgood, C. E., Suci, G. J., and Tannenbaum, P. H. *The Measurement of Meaning* (University of Illinois Press, Urbana, Ill., 342 pp., 1957)
118. Peterson, L. R. Prediction of response in verbal habit hierarchies. *J. Exptl. Psychol.*, **51**, 249-52 (1956)
119. Pickett, J. M. Perception of vowels heard in noises of various spectra. *J. Acoust. Soc. Am.*, **29**, 613-20 (1957)
120. Pickett, J. M. Perception of compound consonants. *Language and Speech*, **1**, 288-304 (1958)
121. Pierce, J. R., and Karlin, J. E. Reading rates and the information rate of a human channel. *Bell System Tech. J.*, **36**, 497-516 (1957)
122. Postman, L., and Rosenzweig, M. R. Practice and transfer in the visual and auditory recognition of verbal stimuli. *Am. J. Psychol.*, **69**, 209-26 (1956)
123. Prothro, E. T., and Keehn, J. D. Stereotypes and semantic space. *J. Social Psychol.*, **45**, 197-209 (1957)
124. Rosenzweig, M. R., and Postman, L. Intelligibility as a function of frequency of usage. *J. Exptl. Psychol.*, **54**, 412-22 (1957)
125. Rosenzweig, M. R., and Postman, L. Frequency of usage and the perception of words. *Science*, **127**, 263-66 (1958)
126. Rubenstein, H., and Aborn, M. Immediate recall as a function of degree of organization and length of study period. *J. Exptl. Psychol.*, **48**, 146-52 (1954)
127. Rubenstein, H., and Aborn, M. Learning, prediction, and readability. *J. Appl. Psychol.*, **42**, 28-32 (1958)
128. Russell, W. A., and Jenkins, J. J. *The Complete Minnesota Norms for Responses*

- to 100 Words from the Kent-Rosanoff Word Association Test: Studies on the Role of Language Behavior, N8-onr-66216, Tech. Rept. No. 11 (University of Minnesota, Minneapolis, Minn., 1954)
129. Ryan, J. J., III. An Experimental Comparison of Response Transfer Facilitated by Meaningfully Similar and Associated Verbal Stimuli: Studies on the Role of Language in Behavior, N8-onr-66216, Tech. Rept. No. 21 (University of Minnesota, Minneapolis, Minn., 1957)
 130. Sakoda, J. M. Individual differences in correlation between clustering and recall of meaningful words. *J. Gen. Psychol.*, **54**, 183-90 (1956)
 131. Saporta, S. Frequency of consonant clusters. *Language*, **31**, 25-30 (1955)
 132. Saporta, S. Linguistic structure as a factor and as a measure in word association. In *Associative Processes in Verbal Behavior: A Report of the Minnesota Conference*, pp. 210-13 (Jenkins, J. J., Ed., University of Minnesota, Minneapolis, Minn., 226 pp., 1955)
 133. Selezneva, I. S. Vospriatia udarenia v slovakh russkogo iazyka. (What roles does the semantic aspect of the word play in the perception of stress?) *Voprosy Psikhologii*, **4**, 70-79 (1957)
 134. Semans, C. B. Use of the semantic differential with lobotomized psychotics. *J. Consulting Psychol.*, **21**, 264 (1957)
 135. Sharp, H. C. Effect of contextual constraint upon recall of verbal passages. *Am. J. Psychol.*, **71**, 568-72 (1958)
 136. Sipola, E., Walker, N. W., and Kolb, D. Task attitudes in word association, projective and nonprojective. *J. Personality*, **23**, 441-59 (1955)
 137. Skinner, B. F. *Verbal Behavior* (Appleton-Century-Crofts, Inc., New York, N. Y., 478 pp., 1957)
 138. Smith, M. E. The application of some measures of language behavior and tension to the letters written by a woman at each decade of her life from 49 to 89 years of age. *J. Gen. Psychol.*, **57**, 289-95 (1957)
 139. Solley, C. M., and Messick, S. J. Probability, learning, the statistical structure of concepts, and the measurement of meaning. *Am. J. Psychol.*, **70**, 161-73 (1957)
 140. Spilka, B. Relationships between certain aspects of personality and some vocal effects of delayed speech feedback. *J. Speech Hearing Disorders*, **19**, 491-503 (1954)
 141. Staats, C. K., and Staats, A. W. Meaning established by classical conditioning. *J. Exptl. Psychol.*, **54**, 74-80 (1957)
 142. Starkweather, J. A. Content-free speech as a source of information about the speaker. *J. Abnormal Social Psychol.*, **52**, 394-402 (1956)
 143. Sumby, W. H., and Pollack, Y. *Short-time Processing of Information*, HFORL Rept., TR-54-6, 12 pp. (1954)
 144. Sumby, W. H., and Pollack, I. Visual contribution to speech intelligibility. *J. Acoust. Soc. Am.*, **26**, 212-15 (1954)
 145. Taylor, J. A. Effect of set for associated words on duration threshold. *Perceptual Motor Skills*, **6**, 131-34 (1956)
 146. Taylor, J. A. Meaning, frequency and visual duration threshold. *J. Exptl. Psychol.*, **55**, 329-34 (1958)
 147. Taylor, W. L. Recent developments in the use of "Cloze Procedure." *Journalism Quart.*, **33**, 42-46, 99 (1956)

148. Thomas, R. B. Electronic computer study of English syntax patterns. *Natl. Bur. Standards (U. S.), Tech. News Bull.*, **41**, 84-86 (1957)
149. Thorndike, E. L., and Lorge, I. *The Teachers' Word Book of 30,000 Words* (Bur. of Publ., Teachers College, Columbia University, New York, N. Y., 274 pp., 1944)
150. Tolhurst, G. C. Audibility-recognition sound pressure functions of the voiced cognate consonants. *J. Speech Hearing Disorders*, **19**, 28-36 (1954)
151. Trager, G. L. Paralanguage: a first approximation. *Studies in Linguistics*, **13**, 1-12 (1958)
152. Triandis, H. C., and Osgood, C. E. A comparative factorial analysis of semantic structures in monolingual Greek and American college students. *J. Abnormal Social Psychol.*, **57**, 187-96 (1958)
153. Weissman, S. L., and Crockett, W. H. Intersensory transfer of verbal material. *Am. J. Psychol.*, **70**, 283-85 (1957)
154. Wepman, J. M., Bock, R. D., Jones, L. V., and Van Pelt, D. Psycholinguistic study of aphasia: a revision of the concept of anomia. *J. Speech Hearing Disorders*, **21**, 468-77 (1956)
155. Winchester, R. A., and Hartman, B. T. Auditory dedifferentiation in the dysphasic. *J. Speech Hearing Disorders*, **20**, 178-82 (1955)

INDUSTRIAL PSYCHOLOGY¹

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This review marks the sixth decade of industrial psychology in America, the beginning of a second decade of descriptions prepared annually relating researches and methodologies of experimental, social, and clinical psychology to the "practice" of psychology within industry.

Over the years there has been little apparent change in "what psychologists are doing" that may be called industrial psychology, but each year has seen the broadening of the contact points between "basic" and "applied" psychology. The topic outlines of the annual reviews have remained much the same from year to year. Some areas have expanded sufficiently to warrant separate review chapters (e.g., human engineering); no areas have really been dropped from consideration. Some topics have become traditional (e.g., selection), and others are slowly beginning to emerge in importance (e.g., decision-making processes). In order to evaluate the current publications covered in this review, let us begin with a brief description of the growth of the contact points between the investigator and the practitioner.

The first annual review of industrial psychology in 1950 saw the influence of the war years on defining problem areas (163). In the review of 1952, Brown & Ghiselli (19) made a point that has become quite significant to the training of industrial psychologists to meet the expressed needs of our industries. Said these authors: "It is not always clearly recognized that the success of an industrial psychologist is dependent upon his knowledge of industry quite as much as upon his understanding of principles of psychology." The present reviewer believes that psychologists now are becoming more aware of the social environment in which they must operate. It is also becoming apparent that industry wants the psychologist trained in basic fundamentals of human behavior, as well as in techniques.

The review of 1953 saw the beginning of a big emphasis on human relations in industry, which is now spilling over into industrial psychology and management texts (74). In 1956 Kendall (98) began his review by noting "... there has been a vast amount of published material dealing with the 'people' problems of industry." Ferguson (50), in his 1958 review, pointed out the importance of the growing contact point between the economist and the psychologist in dealing with problems of mutual interest. Rather than bemoaning the fact that industrial psychology is "heterogeneous and lacking in technical-scientific unity," as one can so easily describe the field, this present reviewer agrees with the point stressed by Katzell (97) in his review of 1957 that "... the demarcation of industrial psychology is after all essen-

¹ The survey of the literature pertaining to this review was completed in April, 1959.

tially a matter of location rather than subject matter." Leavitt (112) has pointed out that, in 1954, Argyris did a review of research in human relations in industry that had very little overlap with the *Annual Review* chapters on either industrial or social psychology. The industrial chapter in the *Annual Review* this same year referred to the *Journal of Applied Psychology* almost 25 per cent of the time. This journal never made the Argyris bibliography at all. This is an indication that there are many individuals currently dealing with "psychological" problems in industry whose training and experience are not identical to the traditional industrial psychologist's.

Analyzing the publications in which industrial psychology articles appear, this reviewer found that, in one recently published text on the subject, only 8 per cent of the bibliography items contained "psychology" in the title of the journal or the book. In another standard text in the field the figure was 17 per cent. Granted, of course, there is no claim that the word "psychology" makes any reference legitimate, it is interesting that, in a text on experimental psychology, our figure on "psychology title" references was 30 per cent. A text on educational psychology and another on general psychology each yielded figures of 50 per cent. Lanier (107) made the point in his review of the first four volumes of the *Annual Review* that "... the literature in (industrial psychology) is quite heterogeneous, and many of the studies are highly 'atomistic' in nature."

TOWARD A GLOBAL VIEW

In contrast to its early "atomistic" approach, restricted largely to problems of personnel psychology, industrial psychology has extended its coverage to what may now be described as "general industrial psychology," subsuming such topics as community surveys, labor-management relations, mental health, and theories of the firm. The reader can get one type of view of this growth by comparing the first and fourth editions of Tiffin's basic text, *Industrial Psychology*. In the 1942 edition emphasis was given to psychology as a "technology," much of the material of the book being original with the author and having never been published previously. The 1958 edition by Tiffin & McCormick (182) is based upon the ever-growing body of research efforts of many people. It places less emphasis on the technology of testing. When one compares the second edition of the Harrell text (73) with the original of a decade earlier, the picture is presented of a growth from the "technical tool" approach to more emphasis on theory and research methods. Leavitt's (111) *Managerial Psychology*, which came out in 1958, relates the field of social psychology to management problems in a text widely used in business schools and in some management training programs in which psychology previously had not even been taught.

During the past year, two accounts telling of the early history of industrial psychology were prepared. Ferguson (49) detailed the development of industrial psychology in America from its early beginnings in 1901, and Farmer (47) gave an account of the beginnings of industrial psychology in

England. If one reviews the industrial psychology literature in any single year, it is difficult to obtain any feeling other than, "Here we go again with more routine performances." A contrary picture is gained when one considers the literature by decades. This reviewer, in collaboration with a number of colleagues, has recently completed a survey of several thousand titles in the field which appeared from 1901 through 1958. From this study we conclude that industrial psychology is heading into an era in which research and development are being systematized, largely because of the expansion of contact points. This has meant more emphasis on research in which experimentally oriented psychologists are beginning to work with others—engineers, sociologists, economists, and managers. Industry itself is sponsoring basic research in psychology as well as in the physical sciences, although most emphasis is still in the class of psychotechnology except for some of the researches going on in places like the Bell Telephone Laboratories and in some military installations.

Little is said in this review about "training" or "safety." Omissions in these areas are due to our inability to find much published on the subjects. The author hears that work that is not getting published is proceeding in the area of military and industrial safety. That it is not finding its way into the literature is unfortunate. As for the area of training, researchers seem to be directing energies elsewhere or else not publishing their data. McGehee (127) may have indicated the need for extended work in this area with his plea for more interchange between the learning theorist and the industrial trainer. We refer the reader who wishes we had included more references on the problems of industrial training to a recently published summary by the Ergonomics Research Society (44) and to memory studies similar to the one reported by Conrad (25).

One more point: we shall include in this review a sampling of ancillary publications which are not strictly psychology but do represent some writings on subjects in which psychologists deal. These articles no doubt contribute a share to the over-all growth of the applications of experimental, social, and clinical psychology to the human problems of industry. They show that more nonpsychologists are talking about psychological problems. We shall begin this review with the more standard types of personnel psychology, working our way toward the newer roles now being played by some psychologists within the industrial complex.

SELECTION AND EVALUATION AT THE WORKER AND SUPERVISORY LEVELS

Spriegel & James (166), in a summary of trends in recruitment and selection practices between 1930 and 1957, conclude that personnel men are depending more and more on the use of tests. Psychologists may well wish that a recent article by Stagner (169) could be given wider circulation among certain industrialists. In this article, dealing with the gullibility of personnel managers, a study is reported showing how easy it is for the unsophisticated

person to be duped by the flattering report on his own fine qualities into purchasing a test which is worthless when evaluated scientifically. (Consulting psychologists might well profit from this article by supplying it to their prospective clients.)

We recommend to the practicing psychologist a summary article by 14 authors dealing with "what is going on" in the test area. It appears in a 127-page report in the *Review of Educational Research* (24). Gellerman (60) gives us warning that personality testing in industry may become seriously discredited unless the privacy of the employee is better protected.

An increasing amount of attention (without much success) continues to be given to the problem of criteria against which to validate tests. One study, using the very practical criterion of turnover, was reported by Ferguson, Wallace & Zelle (51). This study gives evidence that the use of proper selection procedures can reduce turnover among life insurance agents. In contrast to this positive type of information is the report of Mosel & Goheen (139) on the validity of the employment recommendation questionnaire in personnel selection. Here evidence is presented on the validity of a widely used (but little studied) employment questionnaire. This particular device obtains judgments and information by mail from persons familiar with the applicant. Results of these investigations showed practically no value for use in prediction in several areas.

Weitz (190) showed a degree of originality in his study of selecting supervisors with the use of peer ratings. Peer nominations on a 14-item questionnaire were made by a group of life insurance agents. Some of the agents were subsequently promoted to a supervisory position and later rated on the new job performance. The ranks of peer nominations for each of the items were then related to the criterion rating. It was found that this type of nomination is useful in identifying potential supervisory personnel, and is quite predictive of performance.

Glazer, Schwarz & Flanagan (65) indicate that some contribution to the predictive value of paper-and-pencil tests can be made by the addition of interview and situational performance procedures in the selection of supervisory personnel. Their criterion instruments included a supervisory performance report, a performance record, and ratings of supervisor effectiveness. In the fourth of a series of studies, Rothe & Nye (155) again show that production data cannot be picked up casually and used to validate tests or other procedures. The lack of consistency in output from time to time is most striking, especially when there is no financial incentive in operation. Stoltz (174) reports another attempt to obtain criteria for research productivity for a physical science research organization by using a forced-choice rating scale, and Decker (35) describes a study of the value of a mechanical comprehension test as a measure of the qualities contributing to successful performance in supervision. Balma, Maloney & Lawshe (8) describe some correlates of foreman identification with management.

Argyle, Gardner & Cioffi (3), in trying to get at ways of evaluating super-

visory methods, studied 90 working groups with foremen in eight British factories. There was found to be less absenteeism under democratic foremen, but absenteeism was not related to other dimensions of supervision. Labor turnover was reported unrelated to supervision. The results of this particular study indicate that trained foremen do not display a different style of supervision from untrained foremen. One, no doubt, might well be cautioned not to generalize this particular finding too extensively.

In a validity study, Hughes & McNamara (85) found for two custom-built Strong sales keys that valid sales interest patterns can be quite specific and that the available Strong sales keys might give misleading results if used for selection and counseling purposes in some sales areas. In a somewhat similar vein Dunnette, Kirchner & DeGidio (42) indicate that the industrial use of the Edwards Personal Preference Schedule and the California Psychological Inventory should be restricted to situations in which counseling on vocational guidance is the major purpose.

The study of differential self-perceptions of management personnel and line workers was made by Porter (148). A 64-pair forced-choice adjective check list, developed by Ghiselli, was filled out by 463 management personnel and 320 line workers. Management personnel tended more often to describe themselves in terms of leadership-type traits. Line workers more frequently pictured themselves in co-operative-follower terms. Continuing with these types of researches, Longstaff & Beldo (118) found that repeated administrations of alternate forms of the Minnesota Clerical Test showed less practice effects than repeated tests with identical forms.

In the way of "what's new" in tests, Huttner & Miriam-Stene (86) describe a short selection battery for use with first-line supervisors. A battery of 10 short-time-limit practical employment tests was announced by Ford *et al.* (55) after a six-year study of their values.

An important book which may lead to the development of a new and quite different theory of tests has been written by Cronbach & Gleser (28). Here the analysis is focused on the classes of decisions which personnel men make and the utility of tests for these problems. While the analysis of selection, placement, and classification within a decision-theory framework represents a radical departure from orthodoxy, it may nonetheless be viewed as a logical extension of the long history of criticism of a test theory which was reliability-based, and which handled validity so awkwardly.

Krug (105, 106) reports two investigations involving the Ghiselli Self-Description Inventory. The first presented indirect evidence of validity for three keys, but also showed all three to be susceptible to bias generated by "assumed selection" sets. The second study developed a new preference index for the adjectives of the Ghiselli Self-Description Inventory by adding a general selection frame of reference to the usual judgment task employed in preference index determination. It was shown that this preference index, termed a Selection Set Preference Index, would predict the bias demonstrated in the first study.

On the interviewing part of the selection front, the fourth edition of Bingham & Moore's book *How To Interview* was prepared by Gustad (18). Appraisals of employee-efficiency problems and objectives of interviews were described in a new book by Maier (120). Seeing actual transcriptions of interviews, the reader can learn why some interviews go wrong. An experimental investigation of the employment interview in four different types of companies was made by Springbett (167). He found that three factors influence the final decision: information received from the application form and from the appearance of the applicant; evaluation placed on this information; and the time order in which the information is received. Results are interpreted in terms of the Einstellung effects and attitudinal determinants of perception. Some little attention is being given to selection problems of women employees and to human resources [Bennett & Cohen (16); Minor (135); Mitchell (136); Flanagan (53)].

A type of research that may become very important in industry is the work now under way in England on problems of vigilance. Baker (7), for example, found that there is no deterioration in the level of vigilance if the events searched for are regularly spaced in time. Temporal regularity between such events and pacing are major factors in producing deterioration. In addition, motor activity during a vigilance task increases markedly in time, least active subjects tending to be superior performers on the task at hand. These types of studies may well become important in the selection of operators where paying attention to a task is a critical requirement.

Validation studies continue, ranging from the selection of stenographers [Bender (13)] to evaluating feedback from training [Moon & Hariton (137)]. An experimental investigation by Myers (142), undertaken to determine the extent to which the forcing of job ratings could influence results, found five factors. The study involved 82 jobs in an insurance office. Forcing had the effect of increasing the job-level variance explained by the principal factor from 86 per cent in unforced ratings to 98 per cent in forced ratings. Factor loadings of some individual job requirements were also rather markedly affected by forcing.

Using observer's ratings and group performance scores, Deutsch (37) found results to support an interaction hypothesis concerning achievement motivation for nonintellectual tasks. Subjects' ratings showed no interaction effect, but gave results suggesting that ratings were measuring achievement value rather than achievement motive. Creager & Harding (27), in a study on foremen, found that the hierarchical factor model is a useful technique for an analysis of trait ratings.

Tiffin (181) has summarized in a personnel journal six merit-rating systems. These include graphic rating scales, supervisor ranking, employee comparisons, forced-distribution system, the forced-choice method, and critical incidents. Flanagan & Schmid (54) describe an extension of the use of the critical-incident approach to the study of psychopathology. Taylor *et al.* (180), in a second paper on rating scale content, found that job traits

showed greater agreement between first- and second-level supervisors than did personal traits.

Ghiselli & Lodahl (62, 63) studied the relationship between merit ratings assigned to foremen and the distribution of managerial traits within their work groups. Measures of supervisory ability and decision-making approach were obtained from a self-description inventory. Three variables were found to be related significantly to the merit ratings assigned to the foremen: the foreman's own score on the supervisory ability scale; the difference between the foreman's score and that of the highest man in his work group on the supervisory scale; and the skewness of the distribution of Decision-Making Approach scores among the men in the work group. The sum of the three variables was found to correlate .92 with the merit ratings.

EXECUTIVE BEHAVIOR

Progress in scientific prediction of executive success is severely hampered by inability to solve the criterion problem. This is the conclusion of Stark (172), writing in a journal of business. He points out that organization-rank and global-effectiveness ratings have served as success criteria in the field studies to date. Organizational rank is questionable on the grounds that non-merit selection considerations contribute unknown, but probably large, amounts of irrelevant variance. Global-effectiveness ratings are probably too specific to the situations from which they are drawn. Criterion grouping, based on the effectiveness in specific management functions, is suggested as an alternative.

Lawshe, Bolda & Brune (109), in trying to get at management training evaluations, describe a technique for scaling responses to film cases on an employee-orientation continuum and on the extent to which the subjects' responses reflected the ability to use subtle social cues to explain the employees' behavior. This is the first in a series of studies. Other articles will give information on reliabilities and scale validity.

In another vein, Ohmann (146) maintains that the superior-subordinate relationship must start from the basic premise that the manager is in charge of work, not people, and that his authority derives from social utility. Participation does not cancel or reduce the individual accountability of the man in charge. Strategic entrepreneur decisions are the managers' responsibility. A publication on the industrial relations executive, based on the analysis of 500 selected returns of a survey of 1300 executives, gives us another picture of what executives themselves say about their jobs (88). Still another type of description of executive behavior was published in *Fortune* by Stryker (175). More interest is expressed in the need for basic research on top-management people. A number of studies are now under way on this; two have recently been published. From Sweden has come a methodological study by Ramfalk (150). The author reports data on the rules of decision making, on how members of the top-management hierarchy have reacted to the various reasons for promotion, and on what personal characteristics have been found in in-

dividuals selected for leadership. Dearborn & Simon (34) studied a group of 23 executives employed by a single large manufacturing concern. As a part of a company executive-training program the subjects were asked to study standard case materials. Data on the selective perception of each executive support the hypothesis that the individual will perceive those aspects of a situation that relate specifically to the activities and goals of his particular department. Since the situation was one in which the executives were instructed to look at the problem from a company-wide rather than a departmental viewpoint, the data indicate that the criteria of selection have become internalized.

There is a growing list of articles dealing with discussions of executive development, most of them at the nonresearch level. One paper discussed rival theories about mobility and development. Jennings (91) draws a contrast between the beliefs that executive character and ability are the result of a long-run progression, lasting in many cases from childhood to old age, and the newer concept of the upward mobility executive.

PROBLEMS OF ADJUSTMENTS AND AGING

The second book dealing (according to the preface) with psychiatry in industry to appear in the past 30 years was published in 1958 under the authorship of two industrial psychiatrists, McLean & Taylor (129). Emphasis is given to preventive psychiatry, with the prediction that industrial psychiatry is at the threshold of development and expansion. The book is quite elementary for a sophisticated audience, and it omits many of the problem areas of emotional adjustment known well by any good supervisor.

McMurry (131), in discussing mental illness in industry, places importance on two things in terms of "do's." First, he says it is important that selection systems, for employees at all levels through top management, include measures of potential adjustment problems. Second, he makes the point, not often expressed so boldly, that outright dismissal may at time be both beneficial to the organization and to the individual employee. Here is a recognition of the fact that a person's contributions to an organization may be more than offset by the trouble he causes. Unfortunately, we often lack criteria to determine when to "dismiss" and when to "help rehabilitate." Weil (189) looks at the problem of difficulties at work in terms of psychic stress. Work may be impossible for some people because (extending the concept of Selye) of a general nonspecific consumption of available energy in neurotic defenses. Fraser (56) describes some recent work in the study of fatigue that is indirectly related to this problem.

Another recent book, written by two sociologists, lends some understanding to many of the adjustment problems found in industry. This book, by Lipset & Bendix (117), is entitled *Social Mobility in Industrial Society* and involves career planning, means of mobility, process of mobility, and consequences of mobility. In a study of occupationally mobile business men, Abegglen (1) points out that the general problem of the relationships be-

tween social structure and individual personality are not yet well understood. Social mobility appears to offer a strategic point of research into the interrelations of these two broad concepts. The mobile men of this study were found not to be inclined to look for gratification from close relations with other persons. There was a feeling among them of exclusion from peer activities, along with a consciousness of differences in status and income. Presthus (149) has presented a theory of organizational behavior in which three ideal types of accommodation are posited—the "upward mobiles," the "indifferents," and the "ambivalents."

Some light on the over-all problem of emotional adjustment is given by Miner & Anderson (134), who investigated the postwar occupational adjustment of disturbed soldiers. A study of the employment status of samples of men was made about 10 years after discharge. Nearly half of the men with a history of psychosis were unemployed at follow-up as compared with approximately 7 per cent of the controls. The neurotics did not have a reliably higher incidence of unemployment, but did tend to concentrate in the low-level occupations, particularly those of an unskilled nature. The proportion of men working in skilled and supervisory positions among the neurotics was considerably below that of the controls. Clark (23), in discussing the problem of rehabilitation of the mentally subnormal, calls for aid both from industry and from the community.

On the problem of the adjustments of the physically handicapped in industry, most studies show the handicapped to be economic assets. Pockrass (147) gives further evidence to this generalization in a study of selective placement in hiring the handicapped for work with the Air Force. Groth, Hilde & Lyman (68) found that amputees receive adequate pressure cues, but show a pronounced impairment in response speed when a task requires gross movements with the prosthesis. Task complexity, inducing time stress by requiring additional "central integration time," led to performance breakdown and confusion.

A study of the attitudes of the industrial workers toward aging and retirement has been presented by Crook & Heinsteins (29). Increasing interest in the problem of aging can be seen from the recently published annotated bibliography by Ward (186). Gradually, evidence is accumulating to support the hypothesis that many older workers can extend their usefulness through job engineering and equipment redesign. A study by Griew & Tucker (67) supports this contention. They found that older engineering workers could be aided by providing for redundancy and by placing scalar indicators on machine tools. A study in the Air Force by Crook *et al.* (30) also shows some relationship between age and form perception. Such studies provide more evidence that one solution to the problem of the aging worker lies in job re-engineering.

JOB ATTITUDES AND MORALE

In 1957 a symposium on industrial morale problems and measurements was held at the meetings of the Midwestern Psychological Association. Pa-

pers presented at this symposium were published in 1958 (177). Five primary factors of morale were identified in three separate factorial analyses by Baehr & Renck (6). Using different experimental samples and two different scoring methods, these authors identified the factors as: organization and management, immediate supervision, material rewards, fellow employees, and job satisfaction. Roach (151) subjected a 62-item employee-opinion survey to a modified centroid factor analysis after it had been filled out by 2072 clerical and management employees. Twelve factors emerged from the analysis. While there is a specificity of employee attitudes, there is a general attitude which biases this specificity.

Kennedy & O'Neill (99) found that assembly operators, performing highly routine and repetitive tasks, held no less favorable opinions toward their supervisors and to the work situation than did utility men performing a wide variety of these routine tasks. In a study of recruitment, dependency, and morale in the banking industry, McMurry (130) posits a functional relationship between the structured, routinized character of banking operations and organization and the personality configurations of most bank employees. The study was based on some 900 interviews. Guba (69) presents more evidence to substantiate the hypothesis that there is a critical time-and energy-factor in morale and satisfaction.

Clinical studies about the importance of group membership to the productivity and satisfaction of workers have been reported in a book by Zalez-nik, Christensen & Roethlisberger (195). The study was made of 50 workers in a medium-sized manufacturing company. Written for both the scientist and for the business man, this publication speculates upon the contribution business education might make toward the development of the new roles, required by the professional administrator in the new and changing society, that have been brought about by modern science and technology.

College students were asked to describe their job goal at graduation and to rank incentive statements. In this study Bendig & Stillman (14) identified three factors: need achievement vs. fear of failure; interest in job vs. job opportunity for acquiring status; and job autonomy of supervision vs. supervisory dependency. Content analysis of this study gave three major categories: opportunities to help others, job satisfaction, job interest and variety. Triandis (184) makes an important point on the use of criteria in measuring attitude change through training. In a study on the effects of supervisory training in a large manufacturing company, it was found that some supervisors who have a bias against "paper work" may not show as much improvement, as a result of the course, as do others. A course may appear to be less effective than it actually is. This suggests that external criteria, such as accounting department records, may be more desirable than reports for the validation of supervisory training. This reviewer would add that an even better evaluation might include using more actual data at the behavior level, such as critical incidents.

Crosland (31) takes a look at the workers' "rights, power, and status," and concludes that the predominant view among social psychologists appears to be that the problem is basically one of "democratic participation." It is not, however, the mass participation of all workers in the higher management of the enterprise, but the participation of the primary work-group in deciding how its own work should be divided, organized, and remunerated. It is important, says Crosland, that leaders in government, industry, and unions should suppress their "practical man's" suspicion of the social sciences. To this we would like to express our bias by saying—not completely!

LABOR-MANAGEMENT RELATIONS

The dimensionality of union-management relations at the local level is the subject of an important paper by Stagner, Derber & Chalmers (171). Data were collected by intensive interviews of top union officials, and top management people in labor relations, from utility, service, and manufacturing enterprises. This article is based on a statistical treatment of 35 variables. A comparison of typological analysis with a dimensional approach based on factor analysis indicates that each increases the amount of information above that derived from a univariate analysis. Multivariate analysis is judged superior to univariate analysis for this kind of study, but it is not feasible to state that typological or factorial technique is superior. It seems possible that both techniques could profitably be utilized in a single research design. Stagner, Chalmers & Derber (170) found that when measured by the Guttman-type scales, the attitude of management toward the union is uncorrelated with attitude of the union toward management.

Weaver (188) reports on the quantification of the frame of reference in labor-management communication. He finds a semantic barrier present in situations in which labor was stereotyped more than management and assumed more extreme scale positions. One may understand this type of problem in communication even better after reviewing the recent book by Seidman *et al.* (161) on how the worker views his union. One of the basic problems within the union itself is one of communication. Even the understanding of incentive payment systems has been found by Shimmin (164) to be a real problem in communication. This writer calls for a reassessment of incentive payment systems in terms of interpretation to the workers, particularly under those work situations that are constantly changing.

Aside from attitude type of studies, the publications in the labor-management area are marginal, such as sociological analyses in human relations, the foreman's role in arbitration, and analyses of work injuries (45, 141, 9). Three publications making predictions for the future envision closer relationships between economics and psychology in labor-management relations. These are *The Scanlon Plan* (115), *The Coming Revolution in Industrial Relations* (87), and *U. S. Industrial Relations: The Next Twenty Years* (173). A somewhat unique note on communist attitudes, job satisfaction, and union

activities in Italy has been provided by Stagner (168). In this study, it was found that very aggressive individuals will be drawn to communism, whereas frustrated but less belligerent workers will become active in non-Communist unions. This interpretation would lead to the conclusion that the improvement of job satisfaction would be a major weapon against communism. We get partial confirmation of this deduction from the fact that Communist unions have virtually disappeared in this country, but are still strong in Italy, where frustrations are incomparably more severe than in the United States. And, as if psychology did not have enough problems with criteria, Howard (82) introduces the call for "criteria of ability" to be used in labor-management arbitration cases in which the problem centers around the question of the fitness of the person to continue on a job.

THE MARKETING MIX

Research results in the field of advertising and selling often remain locked in the files. At least this is what I am told by some of those people who have been associated with the psychological researches into problems of product distribution. At the "fringe" level, one will find in trade publications any number of articles on such subjects as "decisions behind the Edsel" (92) or "a theory of packaging in the marketing mix" (125). Such scientifically oriented studies as that of Rubenstein & Aborn (157) may well be of importance to advertising, although primarily related to information theory. The clinically-oriented studies of Klein *et al.* (102) could be important for the interpretation of subliminal influences. A few methods type studies do get into the literature. Examples are Friedman's (58) use of game theory models in the allocation of advertising expenditures and preference-analysis procedure, which is useful when one has to deal with group behavior toward products whose qualitative appeal depends upon cost [Benson & Peryam (17)]. In studying consumer attitudes, Rogers & Beal (153) describe the use of projective techniques in interviewing farmers. Yeslin, Vernon & Kerr (194) discuss findings which suggest that the individual who is indecisive, poorly adjusted, or insecure with regard to the sales field, and who is applying for a sales job, becomes emotional in responding to questions which tap these dimensions in a personality inventory, spending a disproportionate amount of time on them.

Brown (20) reported a study in which housewives perceived equally new-baked bread to be fresher when wrapped in cellophane than when wrapped in wax paper. Increasing the relative display width of a well-advertised soap product does not increase the choices of that product by self-service store shoppers, according to the findings of Harris (75). Another kind of study that gets into the "mix" literature is represented by the work of Kenyon & Pronko (100). Their findings, related to previous studies in a series, lend support to the hypothesis that identification of cola beverages is more related to the extent and specific nature of advertising than to taste, giving certain brands, under certain stimulus conditions, a favored position in regard to a readiness-

to-respond with a particular brand name. Jacobi & Walters (90) report a study on the impact of social status on consumer choice in dress-buying by women. Wells, Goi & Seader (191) have shown it is quite possible to change a product image by a heavy advertising investment.

Several articles appeared during the year related to subliminal stimulation. Dixon (40), using a method of closed-loop control to avoid use of verbal reports as a measure of threshold changes on the presentation of visual stimuli, found data to support the hypothesis that the threshold of awareness will vary as a function of subthreshold presentations. At one time this paper probably would not have appeared in a review on applied psychology; it would have been added to those dealing with the 50-year-old academic controversy on the nature of subliminal perception. Toch (183) presented the thesis that practitioners of mass communication, with the help of psychologists, are rapidly acquiring ability to control human behavior, motivation research being one way. Rose (154) discusses motivation research and subliminal advertising in terms of the ethical relationship of psychological science and scientists to industry, the obligation of industry to the consumer public. Barthol & Goldstein (10), in discussing psychology and the invisible sell, end with the conclusion that we need not worry about subliminal stimulation as long as we are protected by our inefficient nervous systems, prejudices, lack of attention, and the inalienable right to completely misunderstand, misinterpret, and ignore what we don't see clearly.

ECONOMIC PSYCHOLOGY

Indications still persist, however slight, that economics and psychology have found some common grounds. Hugh-Jones (84), editor of a book entitled *Human Relations and Modern Management*, begins with the following quotation:

It is very proper that a series on Industrial Economics should begin with a study of Human Relations and Modern Management. For it is being increasingly realized that the ultimate concern of industrial management is with human beings, that no amount of technical expertise in devising mechanical instruments, whether of production or of administration, is of any avail if the human factor is ignored.

Fenn (48) in editing a book, *Management in a Rapidly Changing Economy*, has included material from social psychology, clinical observations, and consumer motivation. Holzman (81) presents an article comparing the economic theory of choice and Miller's models of conflict. They differ only in the assumptions made about the existence of substitute goals. They both employ a restrictive assumption—unidimensionality of a scale for ordering options. When this assumption is dropped, the theory which emerges implies a distinction between short- and long-run conflict termination.

Three "views" seem to be merging: the economic theory of the firm with the criterion of profit maximization; the sociologist's dramatization of the importance of conflicts; and the psychologist's view of individual and group

motivation. This can be exemplified by a paper on social classes and spending behavior. Martineau (124) points out that the kinds of things a person will or will not buy are strongly related to his class membership, and also whether he is mobile or stable. Store loyalties and spend-save aspirations are, in part, class-related. Katona (94, 95, 96) finds that habitual patterns of behavior may develop, in consumer sentiment as well as in purchasing and borrowing, which remain fairly stable among many people over several years, in spite of changes in economic conditions and changes in many other forms of behavior of the same people. However, certain forms of economic expectation appear to be variable in the sense that repetition of the same responses by the same people is infrequent under changing conditions. A theory of behavior is then presented with implications for business-cycle analysis. Change in expectations is due to the acquisition of widely transmitted information of a general nature, to personal experiences, or to errors of measurement. In his paper on the psychology of the recession, Katona states the need for economic psychology, participated in by economists, sociologists, and psychologists. Duncan (41) goes so far as to entitle his paper in *Occupational Psychology* "Psychology for Economists," and calls for a new branch of economic psychology.

THE ANCILLARY PUBLICATIONS

In any one year the reader can find hundreds of articles related to the problems of interest to industrial psychologists. Let us mention a few here for "atmosphere" purposes, remembering that industrial psychology in this country began when, and to a large extent has developed because, the industrialist asked for the professional aid of psychologists. Mentioning a sampling of these writings can help provide a background for our following section on situational variables.

Ackoff (2), writing in *Management Science*, calls for a behavioral theory of communication. In the same journal, Bach (5) predicts that business will have more and more need for the basic findings of the behavioral sciences. Argyris (4), writing in *Human Organization*, points out that behavioral science research increasingly is being recognized by industrial administrators. In the *Journal of the American Society of Training Directors* (158, 43, 119), one will find descriptions of management training programs, money-saving training methods, and discussions related to training needs. From *Public Administration* (152) comes articles on selection and training, from *Factory Management & Maintenance*, a regular column on human relations. In *Personnel Journal*, Kreim (104) asks the question, "Is human relations hurting us?", and Knowles (103) in effect answers in the *California Management Review*, as Cooper (26) speaks of the crisis in human relations in *Business Horizons*. Hollingshead (80), writing in the *Journal of Industrial Engineering*, describes techniques of job analysis, while Marrow (123) talks about experiments with "participation" in the *Bulletin of the Menninger Clinic*, and Moser (140) deals with a similar subject in the *Management Record*. The *Journal of Marketing* carries an article by Zielske (197) on remembering and forgetting

of advertising. Bengé (15) deals with the morale of supervisors in *Advanced Management*, and DeReamer (36) talks about enforcing safety rules in *Supervision*. Other samples of the writings in the areas of human relations, selection, training, and influence that help form the thinking of many of the users of the psychologist's services include those of Belman & Hull (12), Evans (46), Hartman (76), Hoy (83), Karraker (93), Klass (101), Leopold (114), Massarik & Weschler (126), McKean (128), and Trickett (185).

SITUATIONAL VARIABLES

A renewed interest in the study of organizational theories and situational environments within industry appears to be in the making. On the one hand, we find such references as those which appear in an excellent review by Haire (71). At a different level, we find the very practical "business climate" appraisals being carried out by such companies as General Electric (61).

March & Simon (121), in their book *Organizations*, review what has been written on organizational behavior by such diverse observers as executives, the originators of "scientific management," sociologists, psychologists, political scientists, and economists. This book centers around the theme that organizations should be constituted toward the elimination of the artificialities of the classical description of the employee as an instrument, and to replace this abstraction with a new one which recognizes that members of organizations have wants, motives, and drives and are limited in their knowledge and their capacities to learn and to solve problems. Lawrence (108), in a case study of decentralization in a medium-sized super-market chain, deals with the administration of organizational change affecting personnel at management levels. It draws heavily for concepts and research methods on the numerous earlier studies in the field of organizational behavior, as well as the related literature of the behavioral sciences which underlies this broad field. The study helps to break new ground in measuring changes in the behavior patterns of individuals and in focusing attention on the behavior of persons on the management levels of an organization. Isaack (89) makes the point that business success is related to organization theory. Dill (39), in a study of two Norwegian firms, shows how the autonomy of managerial personnel—their decisions for and against independent action—may be influenced by the structure of the environment, by the accessibility of information about the environment, and by the managerial perceptions of the meaning of environmental information. In a case study dealing with organizational leadership, Cicourel (22) discusses the persistent problem of the failure to recognize the "informal" as well as the "formal" aspects of organizational structure. There is a growing literature describing "psychological climates," the "personality of companies," the "shadow of the organization," and the like. Whereas these writings can hardly be called "basic," or even "clinical," they do represent an invitation to psychology, and the other behavioral sciences, to develop techniques for measuring the "character of the organization," for the matching of "individual personalities" with "company personalities."

This reviewer believes that here is an important new area for study by industrial psychologists. Gellerman (59) has presented steps in analyzing the company personality: identifying the men whose attitudes count; defining their goals, tactics, and blindspots; defining the economic challenges facing the company; reviewing company history—particularly in terms of the careers of its leaders; and, finally, making an integration of the total picture. Perhaps a means can be devised for extracting common denominators rather than adding up all the parts to obtain a sum. The influencing factors are certainly economic, historical, and fraught with the personalities of dominant individuals.

A report by Deutsch & Shea, Inc. (38) deals with the impact of industrial environments on creative people, with indications of how to establish a more favorable climate for the work of engineers and scientists. This report, written by technical manpower consultants, may well be worth the attention of the psychologist interested in "climates." In a similar vein, one may wish to review a fringe publication by the Chamber of Commerce of the United States which deals with why managers change jobs and when (21). And even Heal's (78) book on the young executive's wife helps describe a situational variable in industry.

In earlier years we have had community climate studies by behavioral scientists as represented by the *Yankee City* series, *Jonesville*, *Steeltown*, Whyte's "New Suburbia" in *The Organization Man*, and more recently, *Crestwood Heights*. It is worth the note that industry itself is now beginning to do community studies. The General Electric studies of the business climate included a community "psychological test," designed to measure the community's attitudes toward labor and management, and to obtain its feelings on business citizenship. Hodges (79) recently came out with a book entitled *Company and Community*. This community study, supported by 10 companies, was intended for use of management as well as civic and welfare groups interested in securing new industry. Syracuse, N.Y., was selected for study because it has well established company-community relationships, and here considerable "climate" research had been done. One of the findings of the Hodges study was that "participation" is as important for community relationships as it has been reported to be for plant relations in such researches as those described in the Harwood Manufacturing Company studies (57). One aim of the Syracuse studies was to find out how to establish relations "... to help people stay individuals in the face of great pressures for conformity, and hence for social mediocrity."

Miller (132) reports a study of decision-making cliques in community power structures as a test of the working hypothesis that key community leaders influence policy-making by acting in concert with cliques. In this comparative study of an American and English city, it was found that there is not a rigid clique structure with specific clique leaders. On certain issues, however, a high degree of clique solidarity is evidenced. In another type of "climate" study, Morris & Murphy (138) investigated the situs dimension

in occupational structure. The majority of studies of occupational structure have been concerned with the vertical stratification dimension. Theoretical and methodological considerations suggest that such unidimensional analysis is often inadequate in research, and that attention should be given also to the "horizontal" dimension. The utility of situs analysis is discussed, and hypotheses are presented concerning occupational role and social mobility.

Havighurst & Feigenbaum (77) find middle-class people may be community-centered or home-centered in social role performance; but working-class people are either home-centered or generally low in social role and leisure performance. Haller (72) has shown that farm-reared people have low levels of occupational achievement in the nonfarm world, a point of considerable importance to problems of production and supervision. This study found that levels of occupational achievement are correlated with levels of educational and occupational aspiration.

One other kind of perspective on situational climates should be mentioned. Hafeez Zaidi (70) reports on problems of human relations in industry in Pakistan. Here management is faced with the problem of reconciling itself to the increasing importance of the workers' point of view in this "industrially backward" country. In both large and small industries one notes an underestimation of the importance of the workers' needs on the part of the industrialists. Nash (143) reports on the industrialization of a Guatemalan community which sheds some light on interpretation of cause and effect of industrial change. This study covers a wide variety of problems, but emphasizes the importance of the environment to occupational role playing, community living, and beliefs.

Important insights in the work climate may be had through studies such as absenteeism, says Behrend (11). He calls for some emphasis on changing jobs and the organization of work, as well as focusing attention on changing attitudes and behavior, as has been the practice in the past. Sayles (159), in a book on industrial work groups, provides a method for predicting behavior patterns of work groups, presenting data which indicate that management creates its own unique set of human problems when it prescribes a given work flow and division of labor in the plant. This book gives another aspect for understanding labor-management relations as it emphasizes differences, rather than similarities, among work groups. Sexton & Staudt (162) report that the clinical approach has proved successful in improving the ability of executives and line supervisors to communicate effectively by developing their ability to structure ideas on the combined psychological and linguistic basis. Roy (156), in an article on operations research in action, describes a "climate" in which psychologists may become involved. Certainly situational research in industry may well be the next area where psychologists will work on an interdisciplinary team. But what about their acceptance in industry? Newman (145) describes how attempts to employ the services of the behavioral scientists are often thwarted by administrative obstacles. He reports that many business men feel threatened, even if unconsciously, by inquiries

and by new ideas. Paradoxically, the very reasons the behavioral sciences are important are also reasons their use is opposed.

DECISION MAKING

A few theoretical papers are beginning to appear in the industrial literature in the area of problem solving. Wasserman & Silander (192) present an annotated bibliography covering psychological as well as other factors in decision making. Cyert, Dill & March (32), writing on the role of expectation in business decision making, give an analysis of how management uses expectations in making internal investment decisions in relation to theories of business behavior. Wärneryd (187), an experimental psychologist, presents much empirical data on the marketing behavior of firms in a selection of consumer-goods industries and the hypotheses related thereto. Unfortunately (for the casual reader), the author is a bit coy in drawing conclusions from his elaborate study. Newell, Shaw & Simon (144) present the beginnings of an operational theory of human problem solving fruitful in application to the theories of learning, of perception, and of concept formation.

Lawshe *et al.* (110) present an article which is concerned with the development of theoretical expectancy charts and their application in personnel decision making. In another publication, Cyert & March (33) introduce a behavioral theory of organizational decision making. With a somewhat different approach comes an article by Schelling (160) on the strategy of conflict; it contains a prospectus for a reorientation of game theory. Slocum (165) discusses the contributions of sociology to a comprehensive interdisciplinary theory of occupational decision making. Margolis (122) makes an analysis of the firm in terms of rationalism, conventionalism, and behaviorism. This sample of writings leads to the hope that executive decision making in the future may be based on more solid ground than "brainstorming," which, by the way, has been subjected to experimental test and found wanting. Taylor, Berry & Block (178) have shown that, in group participation, "brainstorming" can even inhibit creative thinking. In his article on "the managerial mind," Summer (176) gives hope to the possibility that the business executive of tomorrow will be more professionally oriented.

THE NEWER ROLES OF THE INDUSTRIAL PSYCHOLOGIST

Automation, linear programming, operations research, systems analysis, computer programming, and similar words have been used in the literature of the past year to describe certain aspects of industry with which psychologists are becoming associated. The personnel man today is used to carrying out the decisions of others, but, with the increasing emphasis on the psychological and sociological aspects of modern industry, Winthrop (193) predicts that the personnel man of tomorrow will be making many basic decisions himself. What of management in the 1980s? This is the theme of an article by an industrial psychologist and a professor of industrial administration, Leavitt & Whisler (113). These authors speak of a new information

technology that includes techniques for processing large amounts of information rapidly; the application of statistical and mathematical methods to decision-making problems; and the simulation of higher-order thinking through computer programs. There will be fewer middle managers, and most of those who remain are likely to be routine technicians rather than thinkers. One can imagine the psychological problems arising from the depersonalization of relationships within management and the greater distance between people at different levels. These authors conclude "... we may have to reappraise our traditional notions about the worth of the individual as opposed to the organization, and about the mobility rights of young men on the make." Argyris (4) projects that behavioral science research is increasingly being recognized by administrators. Stieber (173), in a book dealing with the next 20 years of industrial relations, believes that much of what we would hope to be industrial harmony will come from researches in the social sciences. Taylor (179) discussed management development at the crossroads, stressing the realistic point of view that great expectations may lead to disappointment.

We wish to give mention to four recent books which do not directly relate to psychology, but do help point a new directional trend in which a few psychologists are becoming involved: The Grabbe (66) *Handbook of Automation, Computation, and Control* and the Ferguson & Sargent (52) *Linear Programming: Fundamentals and Applications* deal with linear programming, operations research, and certain decision processes related to management. Lipitt, Watson & Westley (116), *The Dynamics of Planned Change*, and Zelomek (196), *A Changing America: At Work and Play*, deal with automated man, the principles and techniques of change which derive from a purposeful decision to effect improvements in a social system achieved with the help of professional guidance. Glanzer (64), in a journal article, describes some psychological aspects of diagnostic skills and their evaluation in a system.

In projecting on the newer roles of the industrial psychologist, Miller (133) states that there are signs pointing to different kinds of questions facing the psychologist of the future aside from the old ones of selection, training, human engineering, and the like. Automation will bring the elimination of many jobs, and will make major changes in others. What parts will the psychologist play to help industry avoid imposing major catastrophes on its employees, ranging from executive officers to line workers? What roles will the psychologist play as a member of an operations analysis group? Miller predicts that there will be need for more psychologists as members of a "development team." Some psychologists now are electing to "follow the systems approach." Carrying, perhaps, the title of "human factors specialist," the psychologist may lose some of his original professional identity. He may serve in the capacity of critic, as a sounding board for management. As a problem-solver, he applies his knowledge in the solution of concrete problems. As a researcher he may tackle problems that are more or less specific to a work situation, using experimental tools to obtain answers. Or, as a theoretician, he frames problems in terms of general psychological variables,

attempting to integrate the growing body of knowledge that we have called "general industrial psychology."

This reviewer concludes that the new trend in dealing with the human problems in industry is toward a more effective interdisciplinary approach in studying the interrelationships among people, work environments, and the processes whereby they interact.

LITERATURE CITED

1. Abegglen, J. C. Personality factors in social mobility: a study of occupationally mobile business men. *Genet. Psychol. Monographs*, **58**, 101-59 (1958)
2. Ackoff, R. L. Towards a behavioral theory of communication. *Management Sci.*, **4**, 218-34 (1958)
3. Argyle, M., Gardner, G., and Cioffi, F. Supervisory methods related to productivity, absenteeism, and labor turnover. *Human Relations*, **11**, 23-40 (1958)
4. Argyris, C. Creating effective research relationships in organizations. *Human Organization*, **17**, 34-40 (1958)
5. Bach, G. L. Some observations on the business school of tomorrow. *Management Sci.*, **4**, 351-64 (1958)
6. Baehr, M. E., and Renck, R. The definition and measurement of employee morale. *Admin. Sci. Quart.*, **3**, 157-84 (1958)
7. Baker, C. H. Attention to visual displays during a vigilance task. *Brit. J. Psychol.*, **50**, 30-36 (1959)
8. Balma, M. J., Maloney, J. C., and Lawshe, C. H. The role of the foreman in modern industry: III. Some correlates of foreman identification with management. *Personnel Psychol.*, **11**, 535-44 (1958)
9. Barker, R. S., and Smith, F. M. Work injuries in the United States, 1957. *Monthly Labor Rev.*, **82**, 46-49 (1959)
10. Barthol, R. P., and Goldstein, M. J. Psychology and the invisible sell. *Calif. Management Rev.*, **1**, 29-35 (1959)
11. Behrend, H. Voluntary absence from work. *Intern. Labor Rev.*, **49**, 109-40 (1959)
12. Belman, H. S., and Hull, T. F. Industrial supervision training at Purdue University. *J. Am. Soc. Training Directors*, **12**, 37-41 (1958)
13. Bender, W. R. G. Validation studies involving successive classes of trainee stenographers. *Personnel Psychol.*, **11**, 491-508 (1958)
14. Bendig, A. W., and Stillman, E. L. Dimensions of job incentives among college students. *J. Appl. Psychol.*, **42**, 367-71 (1958)
15. Bengé, E. J. Morale of supervisors. *Advanced Management*, **24**, 17-19 (1959)
16. Bennett, E. M., and Cohen, L. R. Men and women: personality patterns and contrasts. *Genet. Psychol. Monographs*, **59**, 101-55 (1959)
17. Benson, P. H., and Peryam, D. R. Preference for foods in relation to cost. *J. Appl. Psychol.*, **42**, 171-74 (1958)
18. Bingham, W. V., Moore, B. V., and Gustad, J. W. *How to Interview*, 4th Revised ed. (Harper & Brothers, New York, N. Y., 288 pp., 1959)
19. Brown, C. W., and Ghiselli, E. E. Industrial psychology. *Ann. Rev. Psychol.*, **3**, 205-32 (1952)
20. Brown, R. L. Wrapper influence on the perception of freshness in bread. *J. Appl. Psychol.*, **42**, 257-60 (1958)

21. Chamber of Commerce of the U. S. Why managers change jobs and when. *Nation's Business*, **46**, 72-82 (1958)
22. Cicourel, A. V. The front and back of organizational leadership: a case study. *Pacific Sociol. Rev.*, **1**, 54-58 (1958)
23. Clark, D. F. The industrial rehabilitation of the mentally subnormal. *Occupational Psychol.*, **32**, 89-101 (1958)
24. Committee. Educational and psychological testing. *Rev. Educ. Research*, **29**, 4-131 (1959)
25. Conrad, R. Accuracy of recall using keyset and telephone dial, and the effect of a prefix digit. *J. Appl. Psychol.*, **42**, 285-88 (1958)
26. Cooper, J. H. The crisis in human relations. *Business Horizons*, **1**, 31-37 (1958)
27. Creager, J. A., and Harding, F. D., Jr. A hierarchical factor analysis of foreman behavior. *J. Appl. Psychol.*, **42**, 197-203 (1958)
28. Cronbach, L. J., and Gleser, G. *Psychological Tests and Personnel Decisions* (University of Illinois Press, Urbana, Ill., 165 pp., 1957)
29. Crook, G. H., and Heinstein, M. *The Older Worker in Industry* (University of California Press, Berkeley, Calif., 143 pp., 1958)
30. Crook, M. N., Alexander, E. A., Anderson, E. M. S., Coules, J., Hanson, J. A., and Jeffries, N. T. *Age and Form Perception. School of Aviation Medicine, Pamphlet No. 57-124* (U. S. Air Force, Randolph Air Force Base, 58 pp., 1958)
31. Crosland, C. A. R. What does the worker want? *Encounter*, **12**, 10-17 (1959)
32. Cyert, R. M., Dill, W. R., and March, J. G. The role of expectations in business decision making. *Admin. Sci. Quart.*, **3**, 308-40 (1958)
33. Cyert, R. M., and March, J. G. Introduction to a behavioral theory of organizational decision-making: organizational objectives. In *Modern Organization Theory* (Hairston, M., Ed., John Wiley & Sons, New York, N. Y., in press)
34. Dearborn, D. C., and Simon, H. A. Selective perception: a note on the departmental identifications of executives. *Sociometry*, **21**, 140-44 (1958)
35. Decker, R. L. A study of the value of the Owens-Bennett Mechanical Comprehension Test (Form CC) as a measure of the qualities contributing to successful performance as a supervisor of technical operations in an industrial organization. *J. Appl. Psychol.*, **42**, 50-53 (1958)
36. DeReamer, R. Enforcing safety rules. *Supervision*, **20**, 10-12 (1958)
37. Deutsch, M. Some factors affecting membership motivation and achievement motivation in a group. *Human Relations*, **12**, 81-95 (1959)
38. *Company Climate and Creativity* (Deutsch & Shea, Inc., New York, N. Y., 104 pp., 1958)
39. Dill, W. R. Environment as an influence on managerial autonomy. *Admin. Sci. Quart.*, **2**, 409-43 (1958)
40. Dixon, N. F. Apparent changes in the visual threshold as a function of subliminal stimulation. *Quart. J. Exptl. Psychol.*, **10**, 211-19 (1958)
41. Duncan, D. C. Psychology for economists. *Occupational Psychol.*, **32**, 197-203 (1958)
42. Dunnnette, M. D., Kirchner, W. K., and DeGidio, J. A. Relations among scores on Edwards Personal Preference Schedule, California Psychological Inventory, and Strong Vocational Interest Blank for an industrial sample. *J. Appl. Psychol.*, **42**, 178-81 (1958)
43. Editors. How to train distributors. *Management Methods*, **15**, 31-34, 70-73 (1959)

44. Ergonomics Research Society. Symposium on training. *Ergonomics*, 2, 125-228 (1959)
45. Etzioni, A. Human relations and the foreman *Pacific Sociol. Rev.*, 1, 33-38 (1958)
46. Evans, K. Training today: its whys and hows. *Personnel J.*, 37, 91-93 (1958)
47. Farmer, E. Early days in industrial psychology: an autobiographical note. *Occupational Psychol.*, 32, 264-67 (1958)
48. Fenn, D. H. *Management in a Rapidly Changing Economy* (McGraw-Hill Book Co., New York, N. Y., 339 pp., 1958)
49. Ferguson, L. W. The development of industrial psychology. In *Industrial Psychology*, Chap. 2 (Gilmer, B. v. H., Ed., McGraw-Hill Book Co., New York, N. Y., in press)
50. Ferguson, L. W. Industrial psychology. *Ann. Rev. Psychol.*, 9, 243-66 (1958)
51. Ferguson, L. W., Wallace, S. R., Jr., and Zelle, R. K. Selection and turnover. *Personnel J.*, 37, 376-78 (1959)
52. Ferguson, R. O., and Sargent, L. F. *Linear Programming: Fundamentals and Applications* (McGraw-Hill Book Co., New York, N. Y., 342 pp., 1958)
53. Flanagan, J. C. Personnel research and the better use of human resources. *Personnel*, 35, 50-59 (1958)
54. Flanagan, J. C., and Schmid, F. W. The critical incident approach to the study of psychopathology. *J. Clin. Psychol.*, 15, 136-39 (1959)
55. Ford, J. S., Grimsley, G., Ruch, F. L., and Warren, N. D. *Employee Aptitude Survey* (Psychological Services, Inc., Los Angeles, Calif., 1959)
56. Fraser, D. C. Recent experimental work in the study of fatigue. *Occupational Psychol.*, 32, 258-63 (1958)
57. French, I. R. P., Ross, I. C., Kirby, S., Nelson, J. R., and Smith, P. Employee participation in a program of industrial change. *Personnel*, 35, 16-29 (1958)
58. Friedman, L. Game-theory models in the allocation of advertising expenditures. *Operations Research*, 6, 699-709 (1958)
59. Gellerman, S. W. The company personality. *Management Rev.*, 48, 4-8, 69-76 (1959)
60. Gellerman, S. W. The ethics of personality testing. *Personnel*, 35, 30-35 (1958)
61. *Guide to Making a Business Climate Appraisal* (General Electric Company, Schenectady, N. Y., 19 pp., 1955)
62. Ghiselli, E. E., and Lodahl, T. M. Patterns of managerial traits and group effectiveness. *J. Abnormal Social Psychol.*, 57, 61-66 (1958)
63. Ghiselli, E. E., and Lodahl, T. M. The evaluation of foremen's performance in relation to the internal characteristics of their work groups. *Personnel Psychol.*, 11, 179-87 (1958)
64. Glazer, M. Diagnostic (trouble-shooting) skills and their evaluation. *Occupational Psychol.*, 32, 236-44 (1958)
65. Glazer, R., Schwarz, P. A., and Flanagan, J. C. The contribution of interview and situational performance procedures to the selection of supervisory personnel. *J. Appl. Psychol.*, 42, 69-73 (1958)
66. Grabbe, E. M. *Handbook of Automation, Computation, and Control* (John Wiley & Sons, New York, N. Y., 993 pp., 1958)
67. Griew, S., and Tucker, W. A. The identification of job activities associated with

- age differences in the engineering industry. *J. Appl. Psychol.*, **42**, 278-82 (1958)
68. Groth, H., and Lyman, J. Adequacy of the residual sensory cues for psychomotor performance of arm amputees. *J. Appl. Psychol.*, **42**, 323-28 (1958)
69. Guba, E. G. Morale and satisfaction: a study in past-future time perspective. *Admin. Sci. Quart.*, **3**, 195-209 (1958)
70. Hafeez Zaidi, S. M. Problems of human relations in industry in Pakistan: a preliminary report. *J. Social Psychol.*, **59**, 13-18 (1959)
71. Haire, M. Psychological problems relevant to business and industry. *Psychol. Bull.*, **56**, 169-94 (1959)
72. Haller, A. O. Research problems on the occupational achievement levels of farm-reared people. *Rural Sociol.*, **23**, 355-62 (1958)
73. Harrell, T. W. *Industrial Psychology* (Rinehart & Company, Inc., New York, N. Y., 398 pp., 1958)
74. Harrell, T. W. Industrial psychology. *Ann. Rev. Psychol.*, **4**, 215-38 (1953)
75. Harris, D. H. The effect of display width in merchandising soap. *J. Appl. Psychol.*, **42**, 283-84 (1958)
76. Hartman, R. M. The selection, appraisal, and training of your engineering department. *J. Am. Soc. Training Directors*, **12**, 3-9 (1958)
77. Havighurst, R. J., and Feigenbaum, K. Leisure and life-style. *Am. J. Sociol.*, **44**, 396-404 (1959)
78. Heal, E. *The Young Executive's Wife* (Dodd, Mead & Co., New York, N. Y., 185 pp., 1958)
79. Hodges, W. *Company and Community* (Harper & Brothers, New York, N. Y., 360 pp., 1959)
80. Hollingshead, C. O. Personal job analysis. *J. Ind. Eng.*, **9**, 244-48 (1958)
81. Holzman, M. Theories of choice and conflict in psychology and economics. *J. Conflict Resolution*, **2**, 310-20 (1958)
82. Howard, W. E. Criteria of ability. *Arbitration J.*, **13**, 179-96 (1958)
83. Hoy, G. A., Jr. Human relations. *Factory Management & Maintenance*, **116**, 128-29 (1958)
84. Hugh-Jones, E. M. *Human Relations and Modern Management* (North-Holland Publishing Co., Amsterdam, Netherlands, 256 pp., 1958)
85. Hughes, J. L., and McNamara, W. J. Limitations on the use of Strong Sales Keys for selection and counseling. *J. Appl. Psychol.*, **42**, 93-96 (1958)
86. Huttner, L., and Miriam-Stene, D. Foremen selection in light of a theory of supervision. *Personnel Psychol.*, **11**, 403-9 (1958)
87. *The Coming Revolution in Industrial Relations* (Industrial Relations News, New York, N. Y., 76 pp., 1955)
88. *The Industrial Relations Executive* (Industrial Relations News, New York, N. Y., 67 pp., 1958)
89. Isaack, T. S. Organization theory—business success depends on it. *J. Acad. Management*, **1**, 29-36 (1958)
90. Jacobi, J. E., and Walters, S. G. Social status and consumer choice. *Social Forces*, **36**, 209-14 (1958)
91. Jennings, E. E. Two schools of thought about executive development. *Personnel J.*, **37**, 370-72 (1959)
92. Judge, J. E. Decisions behind the Edsel. *Business Horizons*, **1**, 99-102 (1958)

93. Karraker, W. Teamwork and safety in flight. *Human Organization*, **17**, 3-8 (1958)
94. Katona, G. Attitude change: instability of response and acquisition of experience. *Psychol. Monographs*, **72**(10), 38 pp. (1958)
95. Katona, G. Repetitiousness and variability of consumer behavior. *Human Relations*, **12**, 35-49 (1959)
96. Katona, G. The psychology of the recession. *Am. Psychologist*, **14**, 135-43 (1959)
97. Katzell, R. A. Industrial psychology. *Ann. Rev. Psychol.*, **8**, 237-68 (1957)
98. Kendall, W. E. Industrial psychology. *Ann. Rev. Psychol.*, **7**, 197-232 (1956)
99. Kennedy, J. E., and O'Neill, H. E. Job content and workers opinions. *J. Appl. Psychol.*, **42**, 372-75 (1958)
100. Kenyon, G. Y., and Pronko, N. H. Identification of cola beverages: V. A visual check. *J. Appl. Psychol.*, **42**, 419-22 (1958)
101. Klass, B. The ghost of subliminal advertising. *J. Marketing*, **23**, 146-50 (1958)
102. Klein, G. S., Spence, D. P., Holt, R. R., and Gourevitch, S. Cognition without awareness: subliminal influences upon conscious thought. *J. Abnormal Social Psychol.*, **57**, 255-66 (1958)
103. Knowles, W. H. Human relations in industry: research and concepts. *Calif. Management Rev.*, **1**, 87-105 (1958)
104. Kreim, H. G. Is "human relations" hurting us? *Personnel J.*, **37**, 263-64 (1958)
105. Krug, R. E. The effect of specific selection sets on a forced choice self-description inventory. *J. Appl. Psychol.*, **42**, 89-92 (1958)
106. Krug, R. E. A selection set preference index. *J. Appl. Psychol.*, **42**, 168-70 (1958)
107. Lanier, L. H. An evaluation of the Annual Review of Psychology (Volumes I-IV). *Psychol. Bull.*, **51**, 180-90 (1954)
108. Lawrence, P. R. *The Changing of Organizational Behavior Patterns* (Harvard University Graduate School of Business Administration, Boston, Mass., 237 pp., 1958)
109. Lawshe, C. H., Bolda, R. A., and Brune, R. L. Studies in management training evaluation: I. Scaling responses to human relations training cases. *J. Appl. Psychol.*, **42**, 396-98 (1958)
110. Lawshe, C. H., Bolda, R. A., Brune, R. L., and Auclair, G. Expectancy charts: II. Their theoretical development. *Personnel Psychol.*, **11**, 545-59 (1958)
111. Leavitt, H. J. *Managerial Psychology* (University of Chicago Press, Chicago, Ill., 335 pp., 1958)
112. Leavitt, H. J. The influence of human relations research on psychology: in praise of mavericks. *Ann. Proc. Ind. Relations Research Assoc.* (Industrial Relations Research Association, Madison, Wis., in press, 1959)
113. Leavitt, H. J., and Whisler, T. L. Management in the 1980's. *Harvard Business Rev.*, **36**, 41-48 (1958)
114. Leopold, R. L. Psychology of the interview. *Personnel J.*, **37**, 247-50 (1958)
115. Lesieur, F. G. *The Scanlon Plan* (John Wiley & Sons, New York, N. Y., 169 pp., 1958)
116. Lippitt, R., Watson, J., and Westley, B. *The Dynamics of Planned Change* (Harcourt Brace, New York, N. Y., 312 pp., 1958)
117. Lipset, S. M., and Bendix, R. *Social Mobility in Industrial Society* (University of California Press, Berkeley, Calif., 309 pp., 1959)

118. Longstaff, H. P., and Beldo, L. A. Practice effect on the Minnesota Clerical Test when alternate forms are used. *J. Appl. Psychol.*, **42**, 109-12 (1958)
119. Luntz, L. Identification of training needs. *J. Am. Soc. Training Directors*, **13**, 6 (1959)
120. Maier, N. R. F. *The Appraisal Interview* (John Wiley & Sons, New York, N. Y., 246 pp., 1958)
121. March, J. G., and Simon, H. A. *Organizations* (John Wiley & Sons, New York, N. Y., 262 pp., 1958)
122. Margolis, J. The analysis of the firm: rationalism, conventionalism, and behaviorism. *J. Business*, **31**, 187-99 (1958)
123. Marrow, A. J. Experiments in industrial management. *Bull. Menninger Clin.*, **23**, 52-56 (1959)
124. Martineau, P. Social classes and spending behavior. *J. Marketing*, **23**, 121-30 (1958)
125. Mason, W. R. A theory of packaging in the marketing mix. *Business Horizons*, **1**, 91-95 (1958)
126. Massarik, F., and Weschler, I. R. Empathy revisited: the process of understanding people. *Calif. Management Rev.*, **1**, 36-40 (1959)
127. McGehee, W. Are we using what we know about training? Learning theory and training. *Personnel Psychol.*, **11**, 1-12 (1958)
128. McKean, R. N. *Efficiency in Government Through Systems Analysis* (John Wiley & Sons, New York, N. Y., 336 pp., 1958)
129. McLean, A. A., and Taylor, G. C. *Mental Health in Industry* (McGraw-Hill Book Co., New York, N. Y., 262 pp., 1958)
130. McMurry, R. N. Recruitment, dependency, and morale in the banking industry. *Admin. Sci. Quart.*, **3**, 87-117 (1958)
131. McMurry, R. N. Mental illness in industry. *Harvard Business Rev.*, **37**, 79-86 (1959)
132. Miller, D. C. Decision-making cliques in community power structures: a comparative study of an American and an English city. *Am. J. Sociol.*, **44**, 299-310 (1958)
133. Miller, R. B. The newer roles of the industrial psychologist. In *Industrial Psychology*, Chap. 17 (Gilmer, B. v. H., Ed., McGraw-Hill Book Co., New York, N. Y., in press)
134. Miner, J. B., and Anderson, J. K. The postwar occupational adjustment of emotionally disturbed soldiers. *J. Appl. Psychol.*, **42**, 317-22, (1958)
135. Minor, F. J. The prediction of turnover of clerical employees. *Personnel Psychol.*, **11**, 393-402 (1958)
136. Mitchell, A. W. Women working in the 1960's. *Personnel J.*, **37**, 251-54 (1958)
137. Moon, C. G., and Hariton, T. Evaluating an appraisal and feedback training program. *Personnel*, **35**, 36-41 (1958)
138. Morris, R. T., and Murphy, R. J. The situs dimension in occupational structure. *Am. Sociol. Rev.*, **24**, 231-39 (1959)
139. Mosel, J. N., and Goheen, H. W. The validity of the employment recommendation questionnaire in personnel selection: I. Skill traders. *Personnel Psychol.*, **11**, 481-90 (1958)
140. Moser, G. V. Avoiding pitfalls in conference leading. *Management Record*, **20**, 374-77 (1958)

141. Murphy, J. S. The foreman's role in arbitration. *Arbitration J.*, **13**, 98-102 (1958)
142. Myers, J. H. An experimental investigation of "point" job evaluation systems. *J. Appl. Psychol.*, **42**, 357-61 (1958)
143. Nash, M. Machine age Maya—the industrialization of a Guatemalan community. *Am. Anthropologist*, **60**, 1-118 (1958)
144. Newell, A., Shaw, J. C., and Simon, H. A. Elements of a theory of human problem solving. *Psychol. Rev.*, **65**, 151-66 (1958)
145. Newman, J. W. Working with behavioral scientists. *Harvard Business Rev.*, **36**, 67-74 (1958)
146. Ohmann, O. A. The leader and the led. *Personnel*, **35**, 8-15 (1958)
147. Pockrass, J. Selective placement in hiring the handicapped. *Public Personnel Rev.*, **20**, 25-32 (1959)
148. Porter, L. W. Differential self-perceptions of management personnel and line workers. *J. Appl. Psychol.*, **42**, 105-8 (1958)
149. Presthus, R. V. Toward a theory of organizational behavior. *Admin. Sci. Quart.*, **3**, 48-72 (1958)
150. Ramfalk, C. W. *Top Management Selection* (Swedish Council for Personnel Administration, Stockholm, Sweden, 203 pp., 1957)
151. Roach, D. E. Dimensions of employee morale. *Personnel Psychol.*, **11**, 419-31 (1958)
152. Roberts, J. E. M. Selection, training, and promotion of officers. *Public Admin.*, **36**, 352-65 (1958)
153. Rogers, E. M., and Beal, G. M. Projective techniques in interviewing farmers. *J. Marketing*, **23**, 177-79 (1958)
154. Rose, A. W. Motivation research and subliminal advertising. *Social Research*, **25**, 271-84 (1958)
155. Rothe, H. F., and Nye, C. T. Output ratio among coil winders. *J. Appl. Psychol.*, **42**, 182-86 (1958)
156. Roy, H. J. H. Operations research in action. *Harvard Business Rev.*, **36**, 120-28 (1958)
157. Rubenstein, H., and Aborn, M. Learning, prediction, and readability. *J. Appl. Psychol.*, **42**, 28-32 (1958)
158. Savitt, M. A. The retention of management training. *J. Am. Soc. Training Directors*, **13**, 28-33 (1959)
159. Sayles, L. R. *Behavior of Industrial Work Groups* (John Wiley & Sons, New York, N. Y., 182 pp., 1958)
160. Schelling, T. C. The strategy of conflict: prospectus for a reorientation of game theory. *J. Conflict Resolution*, **2**, 203-64 (1958)
161. Seidman, J., London, J., Karsh, B., and Tagliacozzo, D. L. *The Worker Views His Union* (University of Chicago Press, Chicago, Ill., 299 pp., 1958)
162. Sexton, R., and Staudt, V. The communication clinic approach: a proposed solution to the business communication problem. *J. Gen. Psychol.*, **60**, 57-62 (1959)
163. Shartle, C. L. Industrial psychology. *Ann. Rev. Psychol.*, **1**, 151-72 (1950)
164. Shimmin, S. Workers understanding of incentive payment systems. *Occupational Psychol.*, **32**, 106-10 (1958)
165. Slocum, W. L. Some sociological aspects of occupational choice. *Am. J. Econ. Sociol.*, **18**, 139-47 (1959)

166. Spriegel, W. R., and James, V. A. Trends in recruitment and selection practices. *Personnel*, **35**, 42-48 (1958)
167. Springbett, B. M. Factors affecting the final decision in the employment interview. *Can. J. Psychol.*, **12**, 13-22 (1958)
168. Stagner, R. A note on communist attitudes and job satisfaction. *Personnel Psychol.*, **11**, 509-13 (1958)
169. Stagner, R. The gullibility of personnel managers. *Personnel Psychol.*, **11**, 347-52 (1958)
170. Stagner, R., Chalmers, W. E., and Derber, M. Guttman-type scales for union and management attitudes towards each other. *J. Appl. Psychol.*, **42**, 293-300 (1958)
171. Stagner, R., Derber, M., and Chalmers, W. E. The dimensionality of union-management relations at the local level. *J. Appl. Psychol.*, **43**, 1-7 (1959)
172. Stark, S. Research criteria of executive success. *J. Business*, **32**, 1-14 (1959)
173. Stieber, J. W. (Ed.). *U. S. Industrial Relations: The Next Twenty Years* (Michigan State University Press, East Lansing, Mich., 215 pp., 1958)
174. Stoltz, R. E. Development of a criterion of research productivity. *J. Appl. Psychol.*, **42**, 308-10 (1958)
175. Stryker, P. On the meaning of executive qualities. *Fortune*, **57**, 116-19 (1958)
176. Summer, C. E. The managerial mind. *Harvard Business Rev.*, **37**, 69-78 (1959)
177. Symposium. Industrial morale. *Personnel Psychol.*, **11**, 59-94 (1958)
178. Taylor, D. W., Berry, P. C., and Block, C. H. Group participation, brainstorming, and creative thinking. *Admin. Sci. Quart.*, **3**, 23-47
179. Taylor, E. K. Management development at the crossroads. *Personnel*, **36**, 8-23 (1959)
180. Taylor, E. K., Barrett, R. S., Parker, J. W., and Martens, L. Rating scale content: II. Effect of rating on individual scales. *Personnel Psychol.*, **11**, 519-33 (1958)
181. Tiffin, J. 6 Merit rating systems. *Personnel J.*, **37**, 288-91, 300 (1959)
182. Tiffin, J., and McCormick, E. J. *Industrial Psychology* (Prentice-Hall, New York, N. Y. and Englewood Cliffs, N. J., 584 pp., 1958)
183. Toch, H. H. Psychological research and effective persuasion. *J. Communication*, **8**, 190-98 (1958)
184. Triandis, H. C. Attitude change through training in industry. *Human Organization*, **17**, 27-30 (1958)
185. Trickett, J. M. Something new in management development. *J. Am. Soc. Training Directors*, **13**, 3-10 (1959)
186. Ward, B. A. *Education on the Aging. A Selected Annotated Bibliography*. Bull. No. 11 (U. S. Department of Health, Education and Welfare, Washington, D. C., 145 pp., 1958)
187. Wärneryd, K. E. *Motiv och beslut i företagsledningens marknadspolitiks* (Motives and Decisions in Managers' Marketing Policies) (Norstedts, Stockholm, Sweden, 367 pp., 1957)
188. Weaver, C. H. The quantification of the frame of reference in labor-management communication. *J. Appl. Psychol.*, **42**, 1-9 (1958)
189. Weil, E. Work block: the role of work in mental health. *Psychoanalysis and the Psychoanal. Rev.*, **46**, 41-64 (1959)
190. Weitz, J. Selecting supervisors with peer ratings. *Personnel Psychol.*, **11**, 25-35 (1958)

191. Wells, W. D., Goi, F. J., and Seader, S. A change in a product image. *J. Appl. Psychol.*, **42**, 120-21 (1958)
192. Wasserman, P., and Silander, F. S. *Decision Making: An Annotated Bibliography* (Graduate School of Business and Public Administration, Cornell University, Ithaca, N. Y., 111 pp., 1959)
193. Winthrop, H. Automation and the future of personnel and industrial psychology. *Personnel Guid. J.*, **37**, 326-33 (1959)
194. Yeslin, A. R., Vernon, L. N., and Kerr, W. A. The significance of time spent answering personality inventories. *J. Appl. Psychol.*, **42**, 264-66 (1958)
195. Zaleznik, A., Christensen, C. R., and Roethlisberger, F. J. *The Motivation, Productivity, and Satisfaction of Workers* (Harvard University Press, Cambridge, Mass., 442 pp., 1958)
196. Zelomek, A. W. *A Changing America: At Work and Play* (John Wiley & Sons, New York, N. Y., 181 pp., 1959)
197. Zielske, H. A. The remembering and forgetting of advertising. *J. Marketing*, **23**, 239-43 (1959)

ABNORMALITIES OF BEHAVIOR¹

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As far as this author can tell, the *Annual Review of Psychology* chapters which are entitled "Abnormalities of Behavior" deal with subject matter which especially interests psychiatrists. Each reviewer places a good deal of himself into his review. The review must therefore be to some degree biased by the way articles are selected and how they are reviewed. This author is trained in both biochemistry and psychiatry; he tries to combine these disciplines in a research program. His bias, he hopes, is toward science and the use of the scientific method. If other authors feel they have been neglected due to his biases, he can only say that, because reviewers in this volume vary from year to year, a comprehensive coverage of the literature over the years is at least envisaged.

This author has selected for review articles which in his opinion have spearheaded significant trends in psychiatry, as it is not possible, nor perhaps desirable, to refer to every paper published over his review period. Schizophrenia has occupied a great deal of attention. Because it appears to be the major development of the year, the author has given it much more space than other equally important areas of psychiatry.

Hogben (49) has written a most important critique of probability theory. Heretofore it had seemed that the use of statistical analysis based on probability theory was so firmly established one might as well get used to it and learn something about it. However, this thoughtful and provocative book raises many serious issues. It may perhaps elevate the self-esteem of research scientists who deal with their statistical colleagues. Hogben traces the historical development of probability theory, which arose out of the desires of gamblers to know how to bet on games of chance. Hogben states,

Unless we rely on axioms which are not susceptible of proof we must concede that a calculus of probability is relevant to the real world: (a) only in so far as it specifies frequencies of observable occurrences in an indefinitely protracted sequence of trials, (b) only if also such occurrences collectively constitute a sequence wholly devoid of order.

He questions the right of statisticians to prescribe the design of experiments in accordance with requirements of significance-test procedures and fiducial estimates, suggesting that research techniques used successfully by biologists and chemists again be considered as models.

Another book is most timely. Bartlett (9) analyzes thinking from an ex-

¹ The survey of the literature pertaining to this review covered the period from May, 1958 to May, 1959.

perimental point of view. According to Andrade (4), Sir Isaac Newton, when asked how he made his discoveries, said, "By always thinking unto them," and, again, "I keep the subject constantly before me and wait till the first dawns open little by little into the full light." Perhaps by "thinking unto" Bartlett's analysis we may see this attitude spread into the behavioral sciences. Bartlett's review is excellent. He tries to define and analyze creative thinking and how it is used in science. In view of the current use of models in experimental psychiatry, this statement is apt:

The most important of all conditions of originality in experimental thinking is a capacity to detect overlap and agreement between groups of facts and fields of study which have not before been effectively combined and to bring these groups into experimental contact. Any experimental science is likely to show successive prolonged phases of advance and consolidation as it progresses.

And,

It is well known that points of agreement are inherently less easy to detect than points of difference . . . the detection of differences alone leads nowhere in particular in a positive sense, but the detection of agreement may. . . . It seems fairly certain that, in a cognitive sense, all advance of knowledge comes by using agreements to get a move on, so to speak, and then using differences to keep the move within limits, and to show where a new direction of move becomes necessary. Differences stick out in untutored perception.

Hook (51) edited the proceedings of the Second Annual New York University Institute of Philosophy, held at Washington Square, New York, March 28-29, 1958, into a very provocative volume. A group of psychoanalysts met with a group of philosophers of science in order to deal solely with psychoanalysis as a scientific theory. This volume starts with a review of analytic theory by Hartmann, who referred mostly to the work of Freud because "most of the more general theories of analysis have their origin in it and because he [Freud] is in many ways more representative of psychoanalytic thinking than anybody else." Hartmann's paper is entitled "Psychoanalysis as a Scientific Theory." Therefore, one would expect to find a lucid exposition of this theory and an adequate sample of validated data or observations upon which it is based. However, this is not the case. The paper is chiefly an excellent condensation of Freudian theory, which is considered "more representative" than newer developments. The thesis is: that theory developed 50 years ago has remained so impregnable to experiment that it still remains untouched. Although there are no data whatever in this review, there is an excellent discussion about data, the difficulties of which include mode of operation, interactions, biases, etc. The theory is so excellent, however, that interpreter biases "can be accounted for by analytic theory," always, of course, after the fact.

Nagel, the second contributor, refers to two requirements of theory: (a) "It must be possible to deduce determinate consequences from the assumptions of theory," and (b) Some theoretical notions must be tied down to

fairly definite and unambiguously specified observable materials, by way of rules of procedure variously called "correspondence rules," "coordinating definitions," and "operational definitions." A credible theory must be capable of being negated by evidence. Nagel finds that analysis has not incorporated into itself these basic rules of science and is "not proven."

The rest of the book continues in this vein. The analysts defend and interpret their theories, whereas most of the philosophers deny them the privilege of being called scientists. It is obvious that both classes of specialists were using entirely different frames of reference. The philosophers use certain rules of the game called science which historically go back to Bacon, Descartes, Newton, Pearce, etc. The analysts wish to be scientific, but have developed a new set of rules which is their science. Thus the interchange of ideas is similar to a game of chess with one opponent insisting on using the rules of checkers.

Lazerowitz uses the rules of science in another way, i.e., *ad hominem*, when he examines not the philosophers' ideas but the motives behind them. Freud used this mode of argument against many of his critics. Since motives are usually very obscure, it is much simpler and more productive of thought to examine the idea rather than the motive. Of course, the study of motives is a valid study, but at a different level than the study of ideas. A substantial portion of the discussion is a vigorous attack on Lazerowitz' ideas. This book is interesting in that it demonstrates the wide gulf between analytic "scientific" and philosophic "scientific" thinking.

NEUROSES

The development of data and theory of neuroses is even later along the cycle of discovery discussed by White (133) last year. This author can find little evidence of a new impetus or new idea, as is exemplified by some of the papers which are here reviewed. Greenson (38) described a group of patients in whom screen defenses have influenced personality. These patients are driven by a hunger for screen experiences, but, as a result of screen defenses and screen hunger, build up a screen identity. These patients need a long classical analysis with a reliable, predictable, and incorruptible analyst.

Stein (118) discusses the cliché, which he interprets by analytic doctrine. Vangaard (125) describes a new syndrome—to be seen in pseudoneurotic patients. These people are conscious of offensive sexual or aggressive affects. They have a defect of, or lack of, primary gain of illness. In contrast to neurotic patients, they do not demonstrate any active and persistent striving for a secondary gain and have only feeble, easily-disturbed object relationships, showing tendencies to detachment and withdrawal.

Drellich & Bieber (25) examined a series of 23 premenopausal women about to lose their uteri. Their major concern was about the loss of child-bearing ability. Another major concern related to their ability to continue their duties. Other fears, conscious and subconscious, were reported.

Lesse (71) found that patients exposed to various stresses responded with

a similar pattern of symptom formation. Whatever the technique used for producing stress, the response followed similar patterns. The greater the stress, the greater the anxiety and the more symptoms appear. It was striking that, as the degree of anxiety repeatedly mounted in response to repeated dangers, the pattern of symptom appearance was stereotyped for each patient. Korchin *et al.* (65) found that distortion of perceptual stimuli unknown to the subject increased anxiety. This is not surprising. Many schizophrenic patients describe how perceptual distortions produce anxiety and even panic.

Reducing anxiety decreases psychophysiological symptoms. Franks *et al.* (31) examined prepsychiatric, psychotic, and post-lobotomy records on 67 patients. Lobotomy, usually, according to these authors, produces a bland nonanxious person. They found a notable loss of symptoms in the post-lobotomy period.

Shagass & Jones (107) and Shagass & Kerenyi (108) report more data using the sedation threshold test. Sedation threshold is the quantity of sodium amytal which produces certain EEG and speech changes. They found a positive correlation between anxiety and threshold. Shagass & Kerenyi (109) report that sedation threshold is significantly related to obsessional tendencies. Kawi (60) provides evidence for the reliability of the sedation threshold. Koranyi, Kerenyi & Sarwer-Foner (64) studied the difficulties in adaptation of Hungarian immigrants to life in Canada. Three waves of immigrants were investigated. The first, those who arrived before World War II, have done well, in general, none of them having been seen as patients. The second group came between 1946 and 1956, having left Hungary primarily due to fear of reprisal. The third group arrived after 1956. These had made some adjustment to the Communist regime. They came to Canada completely unprepared for democratic life, accepted welfare measures, and were aggrieved to find that eventually they would have to stand on their own feet. Most adjusted well, but some did not.

Thompson (123) outlined the changes in psychoanalytic objectives during therapy from the early years of analysis to today. The values and goals of psychotherapy were further examined by Schmideberg (106). The author questions whether analysis has any therapeutic advantage over other therapeutic methods. No adequate statistics are available. Schmideberg questions the right of analysts to expect excessive financial or emotional sacrifices from patients, and asks that they give up some of their dogma. The foremost aim of any treatment must be to help the patient as speedily, effectively, and painlessly as possible. Schmideberg fails to understand the analyst. The analyst does indeed feel he is treating his patients as speedily, effectively, and painlessly as possible. For speed is defined as the time required to effect a personality readjustment within a unit time. Thus, even if a drug cures a depression, there is no personality change, and therefore no "cure," in the analytic sense. The analyst feels his to be the only effective way and that any physical treatment is merely an aid to psychotherapy. Ekstein & Wallerstein (28) describe the technique and difficulties of teaching psychotherapy. Their

book will be helpful to teachers of psychotherapy as well as to their students.

Meares (80) re-examined the use of hypnosis in modern therapy. It can be used to shorten the time required for insight therapy, but seems less effective than chemical anesthetics for producing anesthesia in general medicine, obstetrics, and dentistry.

Nelson & Gellhorn (88) found that age causes an increase in the hypotensive action of methacholine (Mecholyl). This indicates a decrease in sympathetic reactivity. They found that autonomic imbalance at various levels of sympathetic reactivity occurred more frequently in psychiatric patients than in controls.

Perhaps the only interesting trend in the treatment of neuroses is the use of the transcendental experience. This is accomplished by giving patients lysergic acid diethylamide (LSD) or mescaline. Thus Giberti & Gregoretti (36) gave LSD to several patients using it as an aid to psychotherapy. Eight patients who were in psychotherapy when they received LSD showed a clear and decisive improvement. Smith (111) used either LSD or mescaline to treat a refractory group of alcoholics. About 50 per cent of a group of 24 were improved or abstinent. Particularly interesting was the brief duration of hospitalization required by this treatment procedure (days compared to usual weeks).

Progress in Psychotherapy, Volume III, Techniques of Psychotherapy, edited by Masserman & Moreno (77), is a compilation of reviews of psychotherapy as related to various uses. It includes something for everyone as well as a discussion by Heath & Leach of taraxein, which will be hard to fit into discussions of psychotherapy.

Another in the series of symposia published in book form is edited by Harlow & Woolsey (42). The discussants present research findings in behavioral psychology, neurophysiology, neuropsychology, and neurochemistry. The old-fashioned books written by one man are easier to understand and read but appear less and less frequently. Hebb, in the closing paragraph of the book, summarizes a general point of view:

The irresponsibility of the empty-organism approach of continuing with the hedonism of 1911 in spite of all the data to the contrary that have been obtained since, and of closing one's eyes to the existence of set and attention and purpose while making an endless elaboration of methodological notions that clearly have not paid off in the development of new knowledge—this kind of irresponsibility can be avoided at least by the physiological psychologist who is obliged to recognize the real complexities of neural function and to see that it is unlikely that we shall solve the problems of behavior without the aid of the biochemist, the geneticist, the anatomist and the physiologist.

NARCOLEPSY AND HYPERSOMNIA

Smith (112) reviewed the relationship between narcolepsy and other sleep-states, as discussed in the literature, and added comprehensive research reports (clinical, psychological, and physiological) on six instances of narco-

lepsy and three of hypersomnia. He concluded there probably is an underlying pathophysiological basis which can be activated by emotional conflict. Evidences for the underlying organic nature of this syndrome are: (a) the four cardinal symptoms—sleep states, cataplexy, sleep paralysis, and hallucinosis—can be plausibly related to the region of the reticular activating substance; (b) infrequent concomitants, e.g., sudden weight-gain, hypogenitality, feminine hair distribution, polyuria, polydipsia, and diabetes insipidus can be similarly explained; (c) narcolepsy can follow encephalitis; (d) bursts of sleep can be so brief it is difficult to see how they are wholly due to psychological conflict; (e) psychological conflict alone as a cause cannot be related to the excellent response to amphetamine and to the fact the EEG can rapidly fluctuate between the drowsy and the alert state without deep sleep, which supposedly would offer the patient succor.

Smith (113) and Smith & Schneider (115) reported some unusual biochemical findings in five narcoleptic patients. Hypoglycemia induced by insulin increased the mental alertness and caused the electroencephalogram to become normal in all these cases. The administration of sugar intravenously was immediately followed by a return of the drowsy state, psychologically and electrically. This may be due to a central liberation of adrenaline with stimulation of the reticular activating substance. Hypoglycemia is a strong stimulus for the secretion of adrenaline. This explanation would fit well with the facts that the reticular activating system is adrenaline-sensitive, that sympathomimetic amines are effective in narcolepsy, and that clinical evidence listed above suggests some dysfunction in the reticular activating substance.

Goldstein & Giffin (37) also conclude narcolepsy is something different from hypersomnia. They made a careful study of 12 patients with hypersomnia. They concluded that patients with a pattern of sleepiness for several hours rather than 15 to 30 minutes, with multiple complaints rather than the classical tetrad, and with disturbed night-sleep, should be considered candidates for psychiatric evaluation. They found that patients with idiopathic narcolepsy usually revealed a pattern of good general adjustment. However, Smith & Hamilton (114) did find a marked relationship between symptoms of narcolepsy and psychological state in six out of seven patients.

DEPRESSION

If psychiatry can be said to have a specific treatment, it is the use of electroconvulsive therapy for the treatment of depression. The results have been uniformly good and predictable. It is therefore noteworthy that the only new developments in the science of the depressions have been the development of chemicals for producing convulsions and for treating depression. Out of 17 papers to be reviewed, 11 deal with these treatments, four deal with some theoretical aspect of the syndrome, and only two deal with clinical matters not related to treatment. There has been no attempt to create a

mechanism or a model for depression which will be of use for the research scientist working with depression.

Walton (127) examined the relationship of parental deprivation, social isolation, and social degeneration in 60 depressed patients who were suicidally inclined and in 163 who were not. Parental deprivation, defined as loss of a parent before age 14 or gross strife between parents or a feeling of prolonged estrangement from one of the parents, was much more frequent in the suicidal group. The other two criteria were not discriminatory between both groups.

Kral (67) described several cases of middle-aged men who had anxiety, tension, and hypochondriacal ruminations. He believes these states were depressions. All had low sedation thresholds and all responded well to electroconvulsive therapy (ECT). He concluded that, in cases where an apparent neurotic reaction does not clear with psychotherapy alone or with drugs, the possibility of a marked depression should be considered.

Iproniazid (Marsilid) counters the feeling of depression. It releases both serotonin and *l*-noradrenaline in the brain. Whether one of these mechanisms is more related to the clinical action is not yet clear. Olds & Olds (89) examined this problem, using self-stimulation experiments in rats. They found that iproniazid and adrenaline are excitants of reward functions. They concluded that the exciting and rewarding effects of iproniazid are connected more with adrenaline than serotonin.

Strom-Olsen (122) found a relationship in three manic-depressive patients between their clinical states and the excretion of catechol amines. The excretion of adrenaline and *l*-noradrenaline was significantly higher in the manic state than in the depressed phase.

Aird (2) finds that the convulsion, and not the electric current, is the therapeutic agent. The physiological effect may be due to the change in the cerebrovascular permeability induced by the convulsion.

Garmany (35) questions the validity of the three diagnostic depression entities,—endogenous depression, reactive depression, and involutional depression. He concludes that such a three-fold distribution is unreal since constitutional predisposition and stress factors were much the same for all three groups. The distinction appears to be primarily between mild and severe depression.

Krantz *et al.* (68) used a gas, hexafluorodiethyl ether (Indoklon), for inducing convulsions. They gave over 1000 treatments to about 80 patients. This was used as an alternative to electroconvulsive therapy (ECT). The inhalant produced the same therapeutic results as ECT and had certain advantages. Similar results were reported in a further communication by Esquibel *et al.* (29).

Iproniazid continues to be used as a treatment for depression. Crane (21), Kline (62), and Robie (101) report the successful treatment of depressions by iproniazid. Robie suggested the jaundice rarely associated with iproniazid may be due to sustained lowering of the blood pressure. Cortisone is an anti-

dote for the hypotension. Kahn & Perez (58) reported a series of nine cases of jaundice which occurred in patients who had been receiving iproniazid. The authors suggest it be given only to patients in whom potential benefits from the drug outweigh the dangers of developing jaundice. Of course, this advice by these authors should be applied to every clinical treatment, including ECT, if we replace the word "jaundice" by the word "death."

A new chemical treatment which shows great promise is imipramine hydrochloride or Tofranil. Kuhn (69) treated over 500 patients. The best response was obtained with endogenous depressions. The initial response occurred within a period of two to 28 days. There were few side-effects. Some brain damaged or schizophrenic patients suffered transitory states of agitation or exacerbation of the psychotic features. Lehmann, Cahn & Verteull (70) reported substantially the same results. Azima (6) and Delay *et al.* (23) agreed.

Abood & Meduna (1) used an anticholinergic psychotomimetic agent for treating depressions. The therapeutic effect became apparent long after hallucinations and autonomic symptoms had disappeared. If these findings are reproduced, they may signify a new theoretical opening into the causation of depression.

Diethelm (24) used chlorpromazine to relieve intense anxiety and agitation in depressions. This allows patients to be more receptive to psychotherapy. If, after the essential psychotherapeutic goals have been reached, the depression is still present (the majority of depressions treated by Diethelm are of middle and late life), the illness is terminated with ECT. One wonders why the depression was not terminated much earlier with ECT and then followed up by psychotherapy. This might have saved the patients great anguish.

NORMAL BEHAVIOR

It is difficult to delineate abnormality from normality. Using a distribution base, all people are normal (within two standard deviations of a hypothetical mean) who manage to lead active lives without the need of seeking psychiatric help (whether the need is their own or that of others). Certain findings in psychiatric patients may occur in normals, so that in themselves the presence of these signs or symptoms is not, per se, proof of psychiatric disease. Medlicott (81) analyzed the significance of hallucinations in the sane (normal). According to Medlicott, the following famous people experienced hallucinations: Socrates, Joan of Arc, Mohammed, Luther, Fox, Bunyan, Napoleon, Raphael, Cellini, Schumann, Goethe, Descartes, Byron, Walter Scott, and Johnson. He concludes that

hallucinations are not so different from normal perceptions and are common in the sane as well as the insane. They may be symptomatic of organic brain disease or of underlying emotional conflict, either psychotic or the psychoneurotic. They may also play an important role in so-called occult phenomena. Even more important, much

of the highly creative inspirational experience of mankind is expressed in hallucinatory form.

Apparently what determines whether the hallucinations are occurring in the sane or insane is determined by the attitude of society and history to these phenomena.

Kohler (63) interprets psychoanalysis as a source of "more and of darker smog" than any other doctrine. (Those who have lived in major industrial areas need not be told how they are affected by smog.) This smog has created a curious symptom. Those who become affected become unable to distinguish clearly between intellectual foods, provided that the food fulfills a main condition of tasting bad. Kohler, after lamenting on this curious illness, emphasizes the need to taste intellectual food which tastes good. An example is a study of obsessions of normal people. Neurotics are not alone in having obsessions, and obsessions must not be studied in the derogatory manner adopted by analysts. "No great novel, no major work of art and no important investigation in science can ever have been completed without a sustaining obsession." Perhaps Kohler would agree that a good example of the obsessional would be the analyst dissecting away the obsessions of his obsessive patient.

Murphy (87) examines human nature in order to determine whether it is possible for man to control his future in such a way as to remove the danger of racial suicide. His final conclusion is that it is possible.

PSYCHOSOMATIC MEDICINE

Very few papers dealing with psychosomatic matters do more than reformulate statements made over the past years. The attempts to find evidence for or against hypotheses are marked by paucity. It appears that authority and repetition are superseding inquiry and investigation. Bressler, Nyhus & Magnussen (18) studied some features in cases of pseudocyesis. They state that pregnancy fantasies are universal in women, but are observed frequently only in neurotic, psychotic, or psychosomatic illnesses. The present reviewer finds it difficult to see how pregnancy fantasies are etiological in pseudocyesis, as these authors suggest, since these fantasies which are universal in women (presumably all women) are only frequent in psychiatrically ill women (not in all women). One would on the contrary assume pregnancy fantasy to be lacking in cases of pseudocyesis. Perhaps further contributions will clarify this interesting paradox.

Williams (134) reviewed the therapeutic response of *anorexia nervosa* of 49 patients. The outcome of the illness was largely unaffected by hospital treatment. He recommends that emergency treatment should be food, even if it must be forced. It is well known that food will prevent dying from inanition.

Fortin, Wittkower & Kalz (30) report that premenstrual tension is psy-

chomatic and should be treated by both psychotherapy and medication. They used a simple oral diuretic as the medication.

Fromm (34) adds another case to the anecdotal analytic psychosomatic literature. A thirteen-year-old obese girl (219 pounds) lost 19 pounds in only 19 psychotherapeutic hours extended over eight months. Lack of co-operation by both parents, especially the father, stopped treatment. The dynamics showed that obesity can have dynamic roots on each and all levels of psychosexual development.

Mohr *et al.* (86) studied six cases of ulcerative colitis in children. The pathogen in each case was the mother. A father with favorable qualities for resolving childhood conflicts toward him antagonized the mother's pathological influence. Jameson (54) treated two children with ulcerative colitis with steroid (prednisone) therapy as well as psychotherapy. Both children showed marked improvement. Will any author claim psychotherapy was adjuvant to drug therapy?

Russek & Zohman (102) compared 100 patients who had coronary disease against 100 controls. They conclude that there are three major predisposing factors, i.e., heredity, high fat diet, and emotional strain. Friedman & Rosenman (33) find that the behavior pattern exhibited by men, and not women, is pathogenic for coronary disease. High cholesterol levels are the result of this behavior. Hereditary factors play no role.

Buck & Hobbs (19) found in a study of 187 individuals that psychosomatic illness tends to be diffuse in its manifestations. This does not favor the idea that psychosomatic disturbance locates in some target organ which has symbolic significance in the personality structure or which has been weakened by other factors.

SCHIZOPHRENIA

Schizophrenia has been the most popular subject this year, if one may judge from the large number of books and reports which have appeared. Physiologists and biochemists have become even more active. This is good, but there is some danger that these scientists may not be aware of psychiatric fact in developing their theories. It is necessary to caution them that biochemical hypotheses which are not firmly based on clinical fact are not better than psychological ideas which neglect biochemistry. Biochemists will need to become more familiar with clinical findings.

BOOK REVIEWS

Bellak's (11) review of schizophrenia covers the period 1946 to 1956. His earlier volume spanned the previous decade. The second volume is an excellent work, and must become familiar to all scientists interested in schizophrenia. Bellak has enlisted the help of a series of authors who contributed chapters to it. The editor's psychoanalytic bias is well curbed, showing up only in his foreword and in the chapters he himself wrote.

Rinkel & Denber (100) have edited the proceedings of the Symposium on Chemical Concepts of Psychosis. The symposium was held at the Second International Congress of Psychiatry in Zurich, September 1st to 7th, 1957. This is a very useful volume, as it summarizes the current attitudes of biological psychiatrists toward psychosis. Part I includes an historical contribution of the chemical concepts of psychosis and some early experiments. In Part II are discussed the chemical, clinical, and physiological investigations of LSD, mescaline, epinephrine metabolites, chelation, serotonin, and indoles. Neuroleptics are discussed in Part III, and schizophrenia in general is discussed in Part IV. It is clear that biochemical research on schizophrenia is very active indeed, even though Bleuler predicted in 1950 that no further biochemical research would be conducted in psychiatry, and Kety reported recently that, if mental disease is structural, the physiological psychologist, the neurophysiologist, or the anatomist is more likely to find meaningful answers long before the biochemist.

Psychopathology, a source book edited by Reed, Alexander & Tomkins (97), is an interesting compilation of research papers published in psychiatric and psychological journals over the past decade. This volume will be helpful to the teacher in psychology and psychiatry.

Two interesting volumes deal with the neurological basis of behavior. The first, by Wolstenholme & O'Connor (136), is the report on a meeting held at Ciba House in London in 1957 to commemorate the birth of Sherrington 100 years ago. The second is a massive volume dealing with the reticular formation of the brain, edited by Jasper and his associates (55).

It is unusual to list a textbook in pharmacology in a review of problems of behavior. The progress of psychopharmacology has been so rapid that such listing is now appropriate. The textbook, edited by Drill (26), contains excellent accounts of the relationship of drugs to the psyche. Psychiatrists and psychologists ought to have this volume, even if they read only a few chapters.

WHAT IS SCHIZOPHRENIA?

Western societies have consistently shut away about one per cent of themselves in mental hospitals for one reason or another. Psychiatrists call most of the shut-aways schizophrenic; yet, in spite of the remarkable uniformity of society in excluding this group, psychiatrists still debate whether their certain set of symptoms constitutes an illness or a faulty way of handling life.

The concept of schizophrenia has been reformulated and restated in an excellent article by the Mental Health Section of the World Health Organization (98). The committee made conclusions which will serve as a useful base upon which to evaluate the progress or failure in schizophrenia research this past year.

The committee reported that the problem was vast and the area of uncertainty only slightly less vast. They suggested the term "schizophrenia"

should be retained as a convenient and appropriate label which covers a heterogeneous group of syndromes (a bow to Bleuler and his "Group of Schizophrenics") with a common psychological structure. The diagnosis must rest upon clinical observations made during the patient's illness—not upon that illness' course (or outcome). The clinical evidence rests upon the total mental state of the patient compared to his previous life and personality. Physical findings act as exclusion factors, e.g., a schizophrenic syndrome caused by benzedrine intoxication would not be diagnosed schizophrenia.

The committee emphasized the need for diagnostic acumen and accuracy. Diagnostic difficulties with patients more often resulted from a neglect of careful skillful examination, i.e., from summary influences from meagre findings and misunderstandings of the value and the limitations of verbal expression.

Certain clinical features comprise prominent criteria for diagnosis, although not one is indispensable. They are: (a) an unmistakable change of personality, (b) autism, (c) disturbances of thinking, (d) a profound emotional disturbance, (e) disturbances of perception, and (f) anomalies of behavior. Nebulous characteristics such as empathy, warmth, etc., are excluded from these diagnostic criteria.

The committee repeatedly stressed the need for diagnosis and insisted that sound classification is essential if psychology is to be a science. The schizophrenic subcategories are not considered essential.

Ehrenthel (27) also tried to clarify diagnostic muddles. He suggested that all causal factors be considered under two chief headings based on (a) pathological-physiological changes which disturb brain function and (b) psychological-sociological factors which determine how the dysfunction will be expressed. This implies that diagnosis should not be too brief. One word should not work too hard.

CAUSE OF SCHIZOPHRENIA

The battle concerning the "cause" of schizophrenia rages on fiercely. Three schools of thought clamor for attention: (a) those who continue to insist schizophrenia is a way of life (albeit a faulty one), (b) those who believe biochemical factors are causative but deny that any biochemical leads present today are of any value, and (c) those who believe they have already witnessed a major breakthrough into the hitherto impenetrable forest of biochemical facts.

Psychogeneticists.—Weakland & Jackson (128) adopted Bateson's "double bind" explanation for part of the etiology. The "double-bind" situation is one in which verbal and nonverbal commands are in conflict. The authors describe a patient who solved this dilemma by becoming schizophrenic (this was involuntary). Although psychotic, he was able to recognize what he had been avoiding.

Wynne *et al.* (138) propose another cause of schizophrenia. People attempt to develop both a personal identity and a set of personal relationships

which may be mutual (symbiotic), nonmutual, or pseudomutual. Pseudomutual is a state which appears to be, but is not, mutual. Acute schizophrenia is a breakdown of pseudo mutuality. Chronic schizophrenia is a compromise between the expression of individuation and a failure of individuation, between achievement and disruption of a relationship. Lidz *et al.* (74) suggest schizophrenic people are prone to withdraw by altering their internal representation of reality because they have been reared amidst irrationality. Nine out of fifteen patients in the series studied had one parent who was schizophrenic.

Jung (57), a pioneer in the development of toxic theories of schizophrenia, still believes such a toxin is present. He arrived at this hypothesis when he found that the psychopathology of hysteria and schizophrenia was similar. Yet they are obviously very different. However, he believes that psychogenic factors cause a secondary elaboration of toxins which, in turn, interfere with cerebral function.

Searles (103) denies that the schizophrenic patient is hostile to his mother. On the contrary, he loves her genuinely. Unless he is made aware of his love, his schizophrenic illness will not be resolved. The mother is unable to accept her child's love. This traumatizes the child and he reacts to it by loving her more. He recognizes his mother is incomplete and unintegrated and this calls forth intense compassion, solicitude, dedication, and loyalty. The discoveries he has made are still unacceptable to him. Therefore he cannot grow away from her and leave her tragically crippled. If it appears the schizophrenic patient is more closely attached to the father, the latter is really a mother-figure.

In a further report, Searles (104) has discovered another etiological factor. An individual becomes schizophrenic partly by reason of a long-continued effort on the part of others to drive him crazy. This attempt is largely or wholly unconscious. Three ways of driving one crazy are given: (a) by simultaneously stimulating and frustrating sexual and other needs, (b) by dealing with the person to be driven crazy on two or more unassociated levels of relatedness simultaneously, and (c) by suddenly switching from one emotional wavelength to another.

Biochemical nihilists.—Kety's (61) review of the current biochemical theories of schizophrenia is adequate, but no more free from the sin of subjective bias than other reviews, including this one. He has discovered at least seven major methodological errors among those who claim they have discovered some factor which characterizes schizophrenics. These errors include: (a) nonspecific institution factors, (b) heterogeneous patient populations and uncertainty in diagnosis, (c) faulty diet, (d) amebiasis, (e) sequelae of previous therapies, (f) stress, and (g) investigator bias.

According to Kety, these faults in research design invalidate most of the work purporting to find differences. This work includes studies which showed that: (a) carbohydrate metabolism is disturbed, (b) amino acid metabolism is unusual, (c) adrenaline metabolites are involved in the cause of schizo-

phrenia, (d) schizophrenic plasma contains taraxein, (e) schizophrenic plasma can be distinguished from normal plasma by biological tests, e.g., the rat-climbing test of Winter & Flataker (135), and (f) serotonin may be related to cause. Nevertheless, genetic studies overwhelm all these negatives, leading Kety to predict that biochemistry will someday achieve something worthwhile; but he still maintains that the biochemist will be the last scientist to do anything useful for schizophrenia, if it is structural.

This review by Kety must be read because it will be vigorously attacked by the aggrieved. It is important to point out that data used by Kety to disaffirm are not entirely free from error as listed by him. The control group used by Kety is not clearly described. The schizophrenic group consists of 14 patients selected from 14,000. Thus, a sample of 0.1 per cent is taken as the ideal schizophrenic sample from which to extrapolate to all schizophrenics, including those in all mental hospitals. Secondly, the normal sample consists of 14 normal volunteers who live under identical conditions for long periods of time. One wonders how normal they are, especially after reading the report by Pollin & Perlin (96), who state that, although there are others, the majority of volunteers at the National Institute of Health are members of two small, closely-related Protestant religious denominations dedicated to peace. Fifteen out of 29 volunteers studied showed significant psychopathology. The incidence of psychopathology varied from 28 per cent among the conscientious objectors to 100 per cent among those who were not members of peace sects nor conscientious objectors, and who were therefore under no pressure to volunteer. Kety in his review does not make clear which group of normal controls he used. It is therefore possible that his own data are not above criticism. It may well be that some of the volunteers with gross psychopathology were schizophrenic.

Benjamin's (12) review of biological research on schizophrenia is written in a similar vein. Benjamin sees some promise in the future of biological research, but remains unconvinced that present research has opened any important lead. He reviews evidence which shows that in schizophrenia: (a) there is no disorder of thyroid function; (b) adrenal steroid hormones are not involved; (c) the catechol amines, whose relationship appeared promising, are not proven to be important; (d) the adrenochrome hypothesis is not confirmed, being felled by "the sort of critical and controlled research exemplified by projects of the National Institute of Mental Health"; (e) the serotonin idea is more interesting and marks a forward step; (f) ceruloplasmin must remain an enzymatic curiosity; and, finally, (g) taraxein does not exist.

Benjamin is puzzled by the current interest in the model psychoses. He finds "it hard to understand how any clinically experienced psychiatrist can be more impressed with the resemblances than with the differences" between schizophrenia and the model psychosis.

Biochemical genesis.—Smythies (116) has reviewed just about the same data as Kety and Benjamin but comes to an opposite conclusion. According to his review, there are only three biochemical theories of schizophrenia: (a)

the adrenaline metabolite theory proposed by Osmond & Smythies (92) and Hoffer, Osmond & Smythies (46); (b) the serotonin idea; and (c) the acetylcholine idea first proposed by Hoffer & Osmond (47) as an integral part of the adrenaline metabolite hypothesis. Smythies concluded that "purely psychogenic theories of the causation of schizophrenia along psychodynamic lines can no longer be held as total explanations of the causation of schizophrenia."

Hoffer & Osmond (48) made a detailed comparison of the model psychosis and schizophrenia. Their model was the adrenochrome model, which is based on the theory that a major biochemical defect exists in schizophrenia in the metabolism of adrenaline. This results in the increased production of adrenochrome, or of similar indoles, to the detriment of cerebral function. The model allows an integration of psychological and sociological factors which induce anxiety with the resultant clinical description, i.e., anxiety leads to discharge of more adrenaline, thus increasing production of adrenochrome and thereby causing more schizophrenia. No other biochemical theory has attempted to show such a relationship.

In comparing the model with natural schizophrenia, Hoffer & Osmond reviewed the same evidence as did Benjamin and Kety, but, again, agreed more with Smythies. They felt that the fact that schizophrenic fluids were different from body fluids of other patients, although not proven, was strongly supported. Adrenochrome and adrenolutin reproduced many of the physiological and psychological features of schizophrenia. In support of the adrenochrome hypothesis, they showed that adrenolutin (an isomer of adrenochrome and derived from it in the body) induced phosphate retention similar to that of schizophrenics in normal volunteers over a portion of the day, as did lysergic acid diethylamide. Treatments based upon the adrenochrome hypothesis were useful in therapy. Thus nicotinic acid or nicotinamide, by decreasing adrenaline production, would decrease adrenochrome production, as would glutathione and ascorbic acid by other mechanisms.

The relationship of serotonin to mental illness was reviewed by Woolley (137). This hypothesis was based on the observation that many indoles, including lysergic acid diethylamide, were serotonin antagonists. LSD has very strong antiserotonin activity. The evidence supporting the serotonin hypothesis is: (a) serotonin is disturbed unequally in the brain; (b) the concentration in the brain is altered by reserpine, which is a tranquilizer; (c) similar substances such as bufotenine are hallucinogenic; (d) high levels of serotonin in the brain can be achieved by giving animals its precursor, 5-hydroxytryptophane. Changes in behavior are found. Woolley refers to some data which create difficulty for the serotonin hypothesis, namely that other compounds very similar in structure to LSD, e.g., brom LSD, are also powerful antiserotonins but do not produce psychological changes. Woolley does not refer to a more serious difficulty, which is that it is not possible at our present level of information to relate serotonin production to anxiety or stress, as can be done with adrenaline.

Sociological factors are not major factors in causing or preventing chron-

icity in schizophrenia, according to Mayer-Gross *et al.* (78). They compared 500 chronic patients in an Indian mental hospital with chronic patients in a mental hospital in England. There were many differences due to the lesser life-expectancy of the Indian patient. Over two-thirds of the Indian men and half of the women were less than 40 years old. Only 132 Indians had been in the hospital more than two years. However, in spite of vast differences in social and cultural background, chronic schizophrenia was present in both societies.

PHYSIOLOGY OF SCHIZOPHRENIA

Whatmore & Ellis (131) believe that motor activity may influence, as well as be the product of, sensation, emotion, and thinking. The authors suggest the term "hyperponesis" for exaggerated activity within the motor portion of the central nervous system. Stevens & Derbyshire (119) question the term stupor as applied to catatonia. This, they believe, is a misnomer due to confusion by psychiatrists of a psychic state and a behavioral manifestation. The catatonic patient is psychically in a state of great excitement whether the behavioral manifestation is one of over- or under-activity. Stokes' (120) contribution on periodic catatonia supports this contention. During catatonic stupor, many bodily functions such as pulse rate, temperature, and blood pressure indicate increased sympathetic activity. In addition, protein breakdown is accelerated and utilization of food stuffs impaired.

BIOCHEMISTRY OF SCHIZOPHRENIA

Excretion of indoles.—Cafruny & Domino (20) found little difference in the excretion pattern of urinary indoles between schizophrenic patients and controls. One unidentified substance was lacking from schizophrenic urine. In contrast, Riegelhaupt (99) and Leyton (73) did find some unknown indoles in schizophrenic urine. McGeer & McGeer (79) presented a comprehensive review of the literature which deals with biochemical differences. They listed 45 papers in which abnormalities in schizophrenic fluids were listed. Only about 15 negative reports were found. Thus, the weight of evidence favors the idea that such differences do exist. Of course, scientific evidence cannot be determined by the simple tabulation methods used in studying public opinion; hence the question must be regarded as unsettled.

Taraxein.—This is a protein, isolated by Heath and his associates (44, 45), from schizophrenic plasma. The original reports created a great deal of controversy, and there is danger polemic will replace considered thought. An example of such polemic is the attack of Siegel *et al.* (110) on the taraxein work. These authors could not reproduce (this seems to be more accurate than "not confirm") Heath's results with taraxein. They made several references to anonymous projects in which no taraxein was found. The reader is thus unable to assess the quality of the work which purports to "not confirm" the taraxein work. The authors also use a technique which this reviewer

finds distressing in research, i.e., to criticize the motives of an author rather than the content of his presentation, the *ad hominem* technique.

Heath and his colleagues provided more evidence that taraxein is psychotomimetic for humans. They did not observe similar reactions in volunteers given control extracts. All subjects given taraxein showed schizophrenic-like symptomatology, especially the primary disturbances in thought and affect. Schizophrenic subjects in remission were more sensitive to taraxein. When schizophrenic serum was injected rapidly, symptoms were induced in volunteers. No taraxein was present in serum of volunteers who had received LSD.

Heath *et al.* further reviewed evidence that adrenaline metabolism is disturbed in schizophrenia. They had suggested earlier that ceruloplasmin, by increasing the oxidation of adrenaline to adrenochrome, might be pathological. However, they now feel that, on the contrary, ceruloplasmin is therapeutic for schizophrenia since schizophrenics lacking ceruloplasmin have an unfavorable prognosis. The increase in ceruloplasmin is a response to stress. Ostfeld, Abood & Marcus (93) found ceruloplasmin levels were elevated in subjects having hallucinations in response to a new hallucinogen. If there were no hallucinations, ceruloplasmin levels remained normal. Martens, Vallbo & Melander (76) find ceruloplasmin very useful as a treatment of schizophrenia.

Two reports have appeared in which the investigators were able to reproduce the extraction of active taraxein. Mekler, Lapteva & Lozovskii (82) used Heath's procedure and isolated a fraction which resembled taraxein. This was an albumin. It produced marked motor inhibitions in mice for a period of time twice as long as did control extracts. The authors state they were able to reproduce Heath's experiments. Melander & Martens (83) also extracted taraxein from schizophrenic patients. This preparation produced behavioral changes in monkeys. Both LSD and taraxein sensitized cats to adrenolutin. They therefore suggested these two substances act by increasing permeability of brain to substances in blood which normally do not cross.

Rat rope-climbing factor.—Winter & Flataker (135) found that plasma from schizophrenic and other psychotic patients markedly interfered with the rope-climbing ability of trained rats, when injected intraperitoneally. These extracts produced a syndrome which resembled that which followed LSD. Control serum was much less toxic. Cerebrospinal fluid was less toxic. Kety (61) referred to work in his laboratory by Kornetsky (66) which did not confirm the Winter & Flataker report. On the other hand, Bergen *et al.* (13) reported that certain fractions from psychiatric patients did markedly interfere in rat rope-climbing.

Other workers have found abnormalities in schizophrenic blood. Streifler & Kornblueth (121) reported that blood sera from schizophrenic patients inhibited glucose uptake of rat retina. There was no difference between acute and chronic patients. Normal sera did not inhibit. Haavaldsen, Lingjaerde &

Walaas (40) reported that the blood of some schizophrenic patients contained a protein fraction which decreased stimulation of glucose uptake by rat diaphragm. They suggested these patients had a decreased capacity for utilizing carbohydrates.

Scarcity of allergies in schizophrenia.—Jodrey & Smith (56) tested the hypothesis that scarcity of allergies in patients with schizophrenia is due to low tissue histamine. They found that schizophrenics released as much histamine when given intradermal curare as controls. Tolerance to histamine was greater in male patients. As the data did not support their hypothesis, the authors concluded that schizophrenic patients had a substance which was responsible for inhibiting the anaphylactic release of histamine without altering the release due to specific compounds such as curare.

PERCEPTION IN SCHIZOPHRENIA

Weckowicz, Sommer & Hall (129) found that distance constancy is poorer in schizophrenia. This condition is related to poorer size constancy. Visual perception appears to lack depth. Therefore, it seems, schizophrenics live in a flatter world. This might account for their complaints that things look different, strange, unreal, and as if painted or cut from cardboard. The lack of three dimensions may influence thinking. Time perspective is also altered.

SCHIZOPHRENIA IN CHILDREN

Pollack & Krieger (95) found that a large proportion of 15 schizophrenic children showed the following deviant oculomotor and vestibular patterns of response: (a) failure to dissociate head and eye movements; (b) involuntary head-turning during autokinetic stimulation; (c) diminished or absent nystagmus following Barany rotation; (d) head and body rotation on passive head turning. These findings may lead to localization of certain defects in the brains of schizophrenic children. Holland, Newman & Hohman (50) reported a series of 12 lobotomized children. After lobotomy, only one remained unmanageable. The authors concluded this treatment was justified in these cases. None was made worse. O'Neal & Robins (90) studied schizophrenic patients 30 years after they had been diagnosed. As children they were involved in antisocial behavior of many kinds including physical aggression, incorrigibility, vandalism, and lying. Half had had police difficulties or juvenile-court appearances. Many were arrested repeatedly before they were diagnosed. They exhibited many fears, phobias, tics, mannerisms, depressions, and paranoid trends.

TREATMENT OF SCHIZOPHRENIA

Psychological.—Eight men exchanged ideas concerning the psychotherapy of schizophrenia and had these exchanges published (132). The general conclusion was that schizophrenia is a multivariable disorder resulting from many interlinking relationships within the family; the family provides a

schizophrenogenic environment which molds the patient as he develops. The patient is a symptom of the illness of the family and, by being ill, maintains the integrity of the family. This is why management of the family is so important in the therapy of the patient. These authors should therefore treat only the family, since a cure induced in the family would remove the need for the symptom; i.e., the schizophrenic patient would immediately recover. Barahal (8) finds analytic therapy useful for treating anxiety in schizophrenia. Diagnosis is unimportant. More important are individual capacities and drives and the type of relationship which the patient can establish with the therapist. The author does not make clear how the anxiety can be present in a schizophrenic patient unless someone diagnoses the illness to be schizophrenia. Gruenthal (39) states there are no medical cures for schizophrenia. Presumably, his definition of cure is a reestablishment of a normal state which thereafter never changes. Using this criterion, there are no cures in medicine whatever. Even though no cure is possible, he finds psychotherapy can be useful in maintaining patients within society.

Measuring change in chronic schizophrenic patients is difficult. Blewett & Stefaniuk (14) developed a scale for assessing change. This scale offers a reliable measure of change in behavior. An orthogonal analysis of a series of chronic schizophrenics provided evidence that chronic hospitalized schizophrenia is essentially a unitary phenomenon.

Biochemical.—Heath and his associates (44) used crude ceruloplasmin for treating schizophrenic patients, with promising results. The patients improved, both clinically and physiologically. Following this lead, Martens, Vallbo & Melander (76) treated a series of 22 schizophrenic patients with intravenous ceruloplasmin. Of the 22 patients, nine became completely well, nine were much improved, and four showed little change. Of the nine who were cured, three relapsed, and required other treatment. None of the improved cases showed any improvement after placebo. Remissions often occurred three-quarters of an hour to several hours following the injection of ceruloplasmin.

Heath *et al.* also administered specially prepared septal tissue digested to a polypeptide. This extract counteracted the action of taraxein in monkeys. In all, the authors gave this extract to 38 patients over an 18-month period. During treatment, glutathione levels in blood increased, serum copper decreased, and adrenaline metabolism became more normal.

Leyton (72) compared the therapeutic responses of 15 schizophrenic patients given insulin coma and glucose with an equivalent group given glucose alone. All other factors were equalized as much as possible. There was no difference between the two treatments. It would be interesting, indeed, if the chief function of insulin was to encourage the administration of copious quantities of sugar.

Freyhan (32) analyzed the responses of 1488 schizophrenic patients hospitalized in Delaware from 1900 to 1950. Between 1940 to 1950, there was

a decisive improvement. The rate of discharge of first admissions increased from 39 per cent at the beginning of the century to 84 per cent in 1950. The chance of discharging readmitted patients increased from 10 to 40 per cent. Death within 10 years after admission decreased from 36 per cent to 3 per cent. The author concludes that somatic treatments have immensely activated the movements of schizophrenic patients, improved chances of separation, and reduced mortality.

Danziger (22) again reports that thyroid medication is very useful for treating chronic schizophrenic patients who have failed other treatment. The daily dose ranges from 1 to 9 mg. thyroxine. Danziger's results are very good. One wonders why other psychiatrists have not reported on the use of thyroid. Perhaps it appears irrational to use a hormone for treating schizophrenic patients where it is "known" no thyroid deficiency is present. Nevertheless, these data cannot be overlooked. It is essential that these trials be duplicated by other psychiatrists.

Apter's (5) report takes one back to the turbulent days of the 1950 wonder drugs. At one time it appeared that cortisone and ACTH would cure anything. Some patients became psychotic while receiving cortisone, which suggested that excess cortico-steroid hormones might be causative. Apter concludes that is not so, on the grounds that four patients who had their adrenal glands removed six years ago are not improved psychiatrically today.

Hospital.—Meszaros & Gallagher (85) found that treating chronic patients with tranquilizers produced improvement in the ward. Even those cases not receiving treatment showed improvement. On regressed wards, improvement was confined to the treated group. The authors attribute these results to better morale and staff attitudes.

Beard, Goertzel & Pearce (10) found group therapy good for treating chronic and regressed patients. Other authors, including Hulse (53), Hora (52), and Scher (105), reported that a structured setting in a ward allowed patients to achieve a better degree of socialization than did a permissive or custodial setting.

Sommer (117) found that elderly patients become "disacculturated." They literally are displaced persons. This can be minimized by providing recreational facilities and community contacts.

EXPERIMENTAL SCHIZOPHRENIA

As the author has noted earlier, psychiatrists who are impressed by the similarity between model psychoses and schizophrenia are not clinically experienced, according to Benjamin (12). It is perhaps truer to say that these psychiatrists have had different clinical experiences, but this does not mean to imply that these are necessarily inferior. Osmond & Hoffer (91) examined the question of the scientific value of models. Model schizophrenics have been criticized for not reproducing faithfully all the manifestations of schizo-

phrenia. It is difficult to know how this can be done, since the total situations differ so greatly. Therefore, nature must make these experiments for us. Such a natural experiment is described in the "Case of Mr. Kovish." Mr. Kovish had asthma for many years, which he controlled by inhaling adrenaline regularly. Several years ago he inhaled a port wine adrenaline for a month. He did not think the color mattered. Immediately after he inhaled this solution, he developed subtle visual perceptual changes, especially when driving his car and when watching people. He became very anxious, doubted his sanity and his own masculinity. His family ascribed his change to family problems, although these were no more severe than previous ones. After he stopped using this adrenaline he made a rapid recovery and has remained well.

Böszörményi & Szara (17) and Halasz, Brunecker & Szara (41) released further reports on two new indole psychotomimetics—dimethyl and diethyl tryptamine. They are similar in structure to bufotenin, serotonin, and tryptophan, as well as adrenolutin (all are indoles). Dimethyl tryptamine, 1 mg. per kg. intramuscularly, produces the usual type of psychotomimetic experience for about one hour. Schizophrenics responded in a different way. The vegetative symptoms came on two to four minutes later and were less intense. There were no visual changes and no prolonged effects on mood or behavior. The authors suggest schizophrenics have some disturbance in metabolism. Böszörményi, Dér & Nagy (16) report diethyl tryptamine can be used as an abreactive agent. Kajtor & Szara (59) find that dimethyl tryptamine causes changes in the EEG as well as psychological changes.

Turner & Merlis (124) conducted some experiments with powdered piptadina seeds. These contain bufotenin, tryptamine derivatives, and other compounds. The authors failed to induce psychological changes in their subjects. Turner & Merlis do not describe clearly whether or not the snuff actually reached the lungs. The Indians in the Caribbean and in South America expect a psychological experience, and know they must inhale the powder very vigorously if they are to receive an effect. One wonders whether the schizophrenic patients used would be as strongly motivated. If the snuff did not penetrate far down the bronchial tree, there would be little response.

Abood & Meduna (1) and Ostfeld *et al.* (94) describe another series of psychotomimetic substances. These are anticholinergic compounds. Given orally they induce confusion, drowsiness, and ataxia. A few hours later they cause disorientation, restlessness, and visual and auditory hallucinations. These compounds from this description are different from mescaline and LSD which, in active dosages, do not produce disorientation and confusion.

Luby *et al.* (75) report another compound, 1-phenyl-1-(1-piperidyl) cyclohexane (Sernyl), which they term schizophrenomimetic. This produces the primary symptoms of schizophrenia, i.e., disturbances in association, inability to maintain a set, concreteness, but no visual hallucinations. There were, however, changes in perception, estrangement, and changes in body image; subjects showed negativism, hostility, drowsiness, and apathy. Since

the drug was developed as an anesthetic, it is not surprising there is drowsiness and apathy. It appears again that this compound differs from LSD and mescaline.

Ames (3) published a very competent account of the psychotomimetic properties of Cannabis, a very well known and ancient substance. However, its chemistry is not worked out in detail. Extracts of Cannabis produced thought disorder, delusions, misperception of time and space, hallucinations, and changes in mood. Ames emphasizes the essential difference between schizophrenia and any model.

The lack of any precise diagnostic criteria for schizophrenia is one difficulty and another is the nature of the experimental setting. The mental abnormality seen was not the result of a slow insidious weakening of the ties with reality but an acute disturbance produced in apparently normal well-adjusted young people. Contact with them was maintained throughout the experiment and this fact deserves special emphasis.

Vernon, McGill & Schiffman (126) subjected 20 volunteers to two types of sensory deprivation, the second being much more thorough than the first. Out of nine volunteers from the first type of deprivation, six experienced hallucinations. When stimuli were more vigorously excluded, only one out of 11 experienced hallucinations. The authors' conclusion is that conditions of confinement which permitted more sensory stimulation also produced more hallucinations. They report that, in other deprivation studies, goggles were used which prevented pattern vision but which allowed light to diffuse. This in itself can induce hallucinations. Thus, it is not confinement which is responsible for the hallucinations, but the lack of pattern vision. If these findings are confirmed, then psychologists have incorrectly labelled these studies as sensory-deprivation studies. They should be termed pattern-deprivation experiments.

Harris (43) used pattern deprivation for testing certain concepts of schizophrenia. It is widely held that schizophrenia is a state of excessive internal mental activity. This interferes with normal interaction between subject and environment and prevents appropriate behavioral responses. Terms such as autism and retreat from reality imply this. Therefore, sensory deprivation (which accentuates the abnormality) should make schizophrenics worse. Conversely, schizophrenics may be unable to deal with inflowing sensations and percepts and to extract meaning from them. In this event sensory deprivation may bring about improvement. Harris (43), therefore, placed 12 schizophrenic patients under sensory deprivation. They were more tolerant than normal subjects of these conditions. Thus, the second hypothesis is favored.

Schizophrenic symptoms can be induced by sensory deprivation (more correctly, alteration of sensory stimuli) as well as by chemicals. Mendelson, Solomon & Lindemann (84) reported that some poliomyelitis patients in respirators developed psychotic-like symptoms. Weisman & Hackett (130)

report that another form of sensory deprivation, i.e. bilateral bandaging of eyes after surgery, can produce psychotic changes. Ziskind (139) reports further on this matter. However, some doubt is thrown on the conclusions from eye surgery by Baker & Farley (7), who report a case of acute confusional psychosis after administration of 1 per cent atropine eyedrops. The atropine was swallowed in the tears. One wonders how many psychoses following eye surgery were atropine psychoses.

Bliss, Clark & West (15) reported psychological changes followed deprivation of sensory deprivation (sleep deprivation). Normal subjects were kept awake 72 hours. Behavioral and subjective changes were considerable. These included feelings of depersonalization, illusions, hallucinations, disturbances in perception of time, and auditory misperceptions. They suggest sleep deprivation may precipitate some acute schizophrenia. Subjects deprived of sleep were more sensitive to LSD. They showed a marked response to half the usual quantity. Thus, it appears that lack of sensory stimulation and over sensory-stimulation can produce psychotic changes in volunteers.

LITERATURE CITED

1. Abood, L. G., and Meduna, L. J. Some effects of a new psychotogen in depressive states. *J. Nervous Mental Disease*, **127**, 546-50 (1958)
2. Aird, R. B. Clinical correlates of electroshock therapy. *A.M.A. Arch. Neurol. Psychiat.*, **79**, 633-39 (1958)
3. Ames, F. A clinical and metabolic study of acute intoxication with *Cannabis sativa* and its role in the model psychoses. *J. Mental Sci.*, **104**, 972-99 (1958)
4. Andrade, E. N. da C. *Sir Isaac Newton: His Life and Work* (Doubleday & Company, Inc., Anchor Books, New York, N. Y., 140 pp., 1958)
5. Apter, N. S. Bilateral adrenalectomy in chronic schizophrenic patients: six years after. *Am. J. Psychiat.*, **115**, 55-59 (1958)
6. Azima, H. Imipramine (Tofranil): a new drug for the depressed. *Can. Med. Assoc. J.*, **80**, 535-40 (1959)
7. Baker, J. P., and Farley, J. D. Toxic psychosis following atropine eye-drops. *Brit. Med. J.*, **II**, 1390-92 (1958)
8. Barahal, H. S. A psychoanalytic approach to schizophrenic anxiety. *Psychiat. Quart.*, **32**, 85-93 (1958)
9. Bartlett, F. C. *Thinking: An Experimental and Social Study* (George Allen & Unwin, Ltd., London, England, 203 pp., 1958)
10. Beard, J. H., Goertzel, V., and Pearce, A. J. The effectiveness of activity group therapy with chronically regressed adult schizophrenics. *Intern. J. Group Psychother.*, **8**, 123-36 (1958)
11. Bellak, L. *Schizophrenia: A Review of the Syndrome* (Logos Press, New York, N. Y., 1010 pp., 1958)
12. Benjamin, J. D. Some considerations in biological research in schizophrenia. *Psychosomat. Med.*, **20**, 427-45 (1958)
13. Bergen, J. R., Pennell, R. B., Hoagland, H., and Freeman, H. Behavior changes in rats produced by a human blood factor. *Federation Proc.*, **18**, 10, March (1959)
14. Blewett, D. B., and Stefaniuk, W. B. Weyburn Assessment Scale. *J. Mental Sci.*, **104**, 359-71 (1958)
15. Bliss, E. L., Clark, L. D., and West, C. D. Studies of sleep deprivation—relationship to schizophrenia. *A.M.A. Arch. Neurol. Psychiat.*, **81**, 348-59 (1959)
16. Böszörményi, Z., Dér, P., and Nagy, T. Observations on the psychotogenic effect of N-N diethyltryptamine, a new tryptamine derivative. *J. Mental Sci.*, **105**, 171-81 (1959)
17. Böszörményi, Z., and Szara, S. Dimethyl tryptamine experiments with psychotics. *J. Mental Sci.*, **104**, 445-53 (1958)
18. Bressler, B., Nyhus, P., and Magnussen, F. Pregnancy fantasies in psychosomatic illness and symptom formation. *Psychosomat. Med.*, **20**, 187-202 (1958)
19. Buck, C., and Hobbs, G. E. The problem of specificity in psychosomatic illness. *J. Psychosomat. Research*, **3**, 227-33 (1959)
20. Cafruny, E. J., and Domino, E. F. Urinary excretion of some products of tryptophan metabolism in schizophrenic patients. *A.M.A. Arch. Neurol. Psychiat.*, **79**, 336-40 (1958)
21. Crane, G. E. Clinical and pharmacological studies of marsilid and theoretical considerations concerning its antidepressant action. *J. Nerv. Mental Disease*, **127**, 238-46 (1958)

22. Danziger, L. Thyroid therapy of schizophrenia. *Diseases of Nervous System*, **19**, 373-78 (1958)
23. Delay, J., Deniker, P., Lempriere, T., Ropert, M., Colin, W., and Ogrizek, B. Étude de l'efficacité de l'imipramine (G 22355) dans le traitement des états dépressifs. *Ann. Med. Psychol.*, **1**, 521-35 (1959)
24. Diethelm, O. Treatment of depressions. *J. Mental Sci.*, **104**, 537-41 (1958)
25. Drellich, M. G., and Bieber, I. The psychologic importance of the uterus and its functions. *J. Nervous Mental Disease*, **126**, 322-36 (1958)
26. Drill, V. A. *Pharmacology in Medicine* (McGraw-Hill Book Co., New York, N. Y., 1243 pp., 1958)
27. Ehrenthel, O. F. The methodological importance of distinguishing two separate causal chains which together produce the clinical picture of psychoses. *Am. J. Psychiat.*, **115**, 220-25 (1958)
28. Ekstein, R., and Wallerstein, R. S. *The Teaching and Learning of Psychotherapy* (Basic Books Inc., New York, N. Y., 334 pp., 1958)
29. Esquibel, A. J., Krantz, J. C., Truitt, E. B., Ling, A. S. C., and Kurland, A. A. Hexafluorodiethyl ether (Indoklon): its use as a convulsant in psychiatric treatment. *J. Nervous Mental Disease*, **126**, 530-34 (1958)
30. Fortin, J. N., Wittkower, E. D., and Kalz, F. A psychosomatic approach to the premenstrual tension syndrome: a preliminary report. *Can. Med. Assoc. J.*, **79**, 978-81 (1958)
31. Franks, J., Haslerud, G. M., Niswander, G. D., and Casey, T. M. Role of anxiety in psychophysiologic reactions. *A.M.A. Arch. Neurol. Psychiat.*, **81**, 227-32 (1959)
32. Freyhan, F. A. The impact of somatic therapies on course and clinical profile of the schizophrenias. *J. Clin. Exptl. Psychopathol. & Quart. Rev. Psychiat. Neurol.*, **19**, 195-201 (1958)
33. Friedman, M., and Rosenman, R. H. Association of specific overt behavior patterns with blood and cardiovascular findings. *J. Am. Med. Assoc.*, **169**, 1286-96 (1959)
34. Fromm, E. Dynamics in a case of obesity. *J. Clin. Exptl. Psychopathol. & Quart. Rev. Psychiat. Neurol.*, **19**, 292-302 (1958)
35. Garmany, G. Depressive states: Their aetiology and treatment. *Brit. Med. J.*, **II**, 341-44 (1958)
36. Giberti, F., and Gregoret, L. Studio comparativo degli effetti psicopatologici della monoetilamide dell'acido lisergico (LAE-32) e della dietilamide dell'acido lisergico (LSD-25) in soggetti neurotici. *Sistema nervoso*, **10**, 97-110 (1958)
37. Goldstein, N. P., and Giffin, M. E. Psychogenic hypersomnia. *Am. J. Psychiat.*, **115**, 922-28 (1959)
38. Greenson, R. R. On screen defenses, screen hunger and screen identity. *J. Am. Psychoanal. Assoc.*, **6**, 242-62 (1958)
39. Gruenthal, M. Aims and limitations of psychotherapy with schizophrenics and borderline cases in private practice. *Am. J. Psychotherapy*, **12**, 465-72 (1958)
40. Haavaldsen, R., Lingjaerde, O., and Walaas, O. Disturbances of carbohydrate metabolism in schizophrenia. *Confinia Neurol.*, **18**, 270-79 (1958)
41. Halasz, A., Brunecker, G., and Szara, S. Dimethyl tryptamin: Ein neues Psychotocum. *Psychiatria et neurologia Hungaria*, **135**, 285-301 (1958)
42. Harlow, H. F., and Woolsey, C. N., Eds. *Biological and Biochemical Bases of Behavior* (The University of Wisconsin Press, Madison, Wisc., 476 pp., 1958)

43. Harris, A. Sensory deprivation and schizophrenia. *J. Mental Sci.*, 105, 235-37 (1959)
44. Heath, R. G., Leach, B. E., Byers, L. W., Martens, S., and Feigley, C. A. Pharmacological and biological psychotherapy. *Am. J. Psychiat.*, 114, 683-89 (1958)
45. Heath, R. G., Martens, S., Leach, B. E., Cohen, M., and Feigley, C. A. Behavioral changes in nonpsychotic volunteers following the administration of taraxein, the substance obtained from serum of schizophrenic patients. *Am. J. Psychiat.*, 114, 917-20 (1958)
46. Hoffer, A., Osmond, H., and Smythies, J. Schizophrenia: a new approach. *J. Mental Sci.*, 100, 29-45 (1954)
47. Hoffer, A., and Osmond, H. Schizophrenia: an autonomic disease. *J. Nervous Mental Disease*, 122, 448-52 (1955)
48. Hoffer, A., and Osmond, H. The adrenochrome model and schizophrenia. *J. Nervous Mental Disease*, 128, 18-35 (1959)
49. Hogben, L. *Statistical Theory: The Relationship of Probability, Credibility and Error* (George Allen & Unwin, Ltd., London, England, 510 pp., 1957)
50. Holland, H. C., Newman, E. G., and Hohman, L. B. Effects of lobotomy in childhood. *Diseases of Nervous System*, 19, 201-7 (1958)
51. Hook, S. *Psychoanalysis, Scientific Method and Philosophy* (New York University Press, New York, N. Y., 370 pp., 1959)
52. Hora, T. The schizophrenic patient in the therapy group. *J. Hillside Hosp.*, 7, 110-15 (1958)
53. Hulse, W. C. Psychotherapy with ambulatory schizophrenic patients in mixed analytic groups. *A.M.A. Arch. Neurol. Psychiat.*, 79, 681-87 (1958)
54. Jameson, G. K. Steroid therapy adjuvant to psychotherapy of childhood ulcerative colitis. *Diseases of Nervous System*, 20, 130-34 (1959)
55. Jasper, H. H., Proctor, L. D., Knighton, R. S., Noshay, W. C., and Costello, R. T. *Reticular Formation of the Brain* (Little, Brown & Co., Boston, 766 pp., 1958)
56. Jodrey, L. H., and Smith, J. A. Releasable histamine levels and histamine tolerance in tissues of 291 psychotic patients. *Am. J. Psychiat.*, 115, 801-7 (1959)
57. Jung, C. G. Die Schizophrenie. *Schweiz. Arch. Neurol. Psychiat.*, 81, 163-77 (1958)
58. Kahn, M., and Perez, V. Jaundice associated with the administration of iproniazid. *Am. J. Med.*, 25, 898-916 (1958)
59. Kajtor, J., and Szara, S. Electroencephalographic changes induced by dimethyl tryptamine in normal adults. *Confinia Neurol.*, 19, 52-61 (1959)
60. Kawi, A. A. The sedation threshold. *A.M.A. Arch. Neurol. Psychiat.*, 80, 232-36 (1958)
61. Kety, S. S. An examination of current biochemical theories of schizophrenia. *Third International Neurochemical Symposium* (Strasbourg, France, August 25-29, 1958); Biochemical theories of schizophrenia. *Science*, 129, 1528-32, 1590-96 (1959)
62. Kline, N. S. Clinical experience with iproniazid (Marsilid). *J. Clin. Exptl. Psychopathol.*, 192, Special Suppl., 72-79 (1958)
63. Kohler, W. *The Obsessions of Normal People* (Presented at the Inauguration of the Graduate School of Arts and Science, Brandeis University, Waltham, Mass., June, 1958)

64. Koranyi, E. K., Kerenyi, A., and Sarwer-Foner, G. J. On adaptive difficulties of some Hungarian immigrants. *Med. Services J., Can.*, **14**, 383-405 (1958)
65. Korchin, S. J., Basowitz, H., Grinker, R. R., Hamburg, D. A., Persky, H., Sabshin, M., Heath, R., and Board, F. A. Experience of perceptual distortion as a source of anxiety. *A.M.A. Arch. Neurol. Psychiat.*, **80**, 98-113 (1958)
66. Kornetsky, C. In Kety, S. S. An examination of current biochemical theories of schizophrenia. *Third International Neurochemical Symposium* (Strasbourg, France, August 25-29, 1958); Biochemical theories of schizophrenia, *Science*, **129**, 1528-32, 1590-96 (1959)
67. Kral, V. A. Marked depression in middle aged men. *Can. Med. Assoc. J.*, **79**, 1-5 (1958)
68. Krantz, J. C., Jr., Esquibel, A., Truitt, E. B., Ling, A. S. C., and Kurland, A. A. Hexafluorodiethyl ether (Indoklon): an inhalant convulsant. *J. Am. Med. Assoc.*, **166**, 1555-62 (1958)
69. Kuhn, R. The treatment of depressive states with G 22355 (imipramine hydrochloride). *Am. J. Psychiat.*, **115**, 459-64 (1958)
70. Lehmann, H. E., Cahn, C. H., and Verteull, R. L. The treatment of depressive conditions with imipramine (G 22355). *Can. Psychiat. Assoc. J.*, **3**, 155-64 (1958)
71. Lesse, S. Psychodynamic relationships between the degree of anxiety and other clinical symptoms. *J. Nervous Mental Disease*, **127**, 124-30 (1958)
72. Leyton, S. R. Glucose and insulin in schizophrenia. *Lancet*, **I**, 1253-54 (1958)
73. Leyton, G. B. Indolic compounds in the urine of schizophrenics. *Brit. Med. J.*, **II**, 1136-39 (1958)
74. Lidz, T., Cornelison, A., Terry, D., and Fleck, S. Intrafamilial environment of the schizophrenic patient. VI. The transmission of irrationality. *A.M.A. Arch. Neurol. Psychiat.*, **79**, 305-16 (1958)
75. Luby, E. D., Cohen, B. D., Rosenbaum, G., Gottlieb, J. S., and Kelley, R. Study of a new schizophrenomimetic drug—Sernyl. *A.M.A. Arch. Neurol. Psychiat.*, **81**, 363-69 (1959)
76. Martens, S., Vallbo, S., and Melander, B. Effects of ceruloplasmin administration to schizophrenics. In *Biological Psychiatry* (Masserman, J. A., Ed., Grune & Stratton, Inc., New York, N. Y., 338 pp., 1959)
77. Masserman, J. H., and Moreno, J. L., Eds. *Progress in psychotherapy. Volume III. Techniques of Psychotherapy* (Grune & Stratton, Inc., New York, N. Y., 324 pp., 1958)
78. Mayer-Gross, W., Cross, K. W., Harrington, J. A., and Sreenivasan, U. The chronic mental patient in India and in England. *Lancet*, **I**, 1265-67 (1958)
79. McGeer, E. G., and McGeer, P. L. Physiological effects of schizophrenic body fluids. *J. Mental. Sci.*, **105**, 1-19 (1959)
80. Meares, A. Hypnosis: an evaluation of its place in medicine. *Med. J. Australia*, **2**, 857-58 (1958)
81. Medlicott, R. W. An inquiry into the significance of hallucinations with special reference to their occurrence in the sane. *Intern. Record Med.*, **71**, 664-77 (1958)
82. Mekler, L. B., Lapteva, N. N., and Lozovskii, D. V. The extraction of toxic albumin from the serum of schizophrenic patients. *Zhur. Nevropatol i Psikiatrii*, **58**, 703-4 (1958)
83. Melander, B., and Martens, S. The mode of action of taraxein and LSD. *Diseases of Nervous System*, **19**, 478-79 (1958)

84. Mendelson, J., Solomon, P., and Lindemann, E. Hallucinations of poliomyelitis patients during treatment in a respirator. *J. Nervous Mental Disease*, **126**, 421-28 (1958)
85. Meszaros, A. F., and Gallagher, D. L. Measuring indirect effects of treatment on chronic wards. *Diseases of Nervous System*, **19**, 167-72 (1958)
86. Mohr, G. J., Josselyn, I. M., Spurlock, J., and Barron, S. H. Studies in ulcerative colitis. *Am. J. Psychiat.*, **114**, 1067-76 (1958)
87. Murphy, G. *Human Potentialities* (Basic Books, Inc., New York, N. Y., 340 pp. 1958)
88. Nelson, R., and Gellhorn, E. The influence of age and functional neuropsychiatric disorders on sympathetic and parasympathetic functions. *J. Psychosomat. Research*, **3**, 12-26 (1958)
89. Olds, J., and Olds, M. E. Positive reinforcement produced by stimulating hypothalamus with iproniazid and other compounds. *Science*, **127**, 1175-76 (1958)
90. O'Neal, P., and Robins, L. N. Childhood patterns predictive of adult schizophrenia: a thirty year follow up study. *Am. J. Psychiat.*, **115**, 385-91 (1958)
91. Osmond, H., and Hoffer, A. The case of Mr. Kovish. *J. Mental Sci.*, **104**, 302-25 (1958)
92. Osmond, H., and Smythies, J. Schizophrenia: a new approach. *J. Mental Sci.*, **98**, 309-15 (1952)
93. Ostfeld, A. M., Abood, L. G., and Marcus, D. A. Studies with ceruloplasmin and a new hallucinogen. *A.M.A. Arch. Neurol. Psychiat.*, **79**, 317-22 (1958)
94. Ostfeld, A. M., Visotsky, H., Abood, L., and Lebovitz, B. Z. Studies with a new hallucinogen. *A.M.A. Arch. Neurol. Psychiat.*, **81**, 256-63 (1959)
95. Pollack, M., and Krieger, H. P. Oculomotor and postural patterns in schizophrenic children. *A.M.A. Arch. Neurol. Psychiat.*, **79**, 720-26 (1958)
96. Pollin, W., and Perlin, S. Psychiatric evaluation of "normal control" volunteers. *Am. J. Psychiat.*, **115**, 129-33 (1958)
97. Reed, C. F., Alexander, I. E., and Tomkins, S. S. *Psychopathology: A Source Book* (Harvard University Press, Cambridge, Mass., 803 pp., 1958)
98. *Report of World Health Organization, Study Group on Schizophrenia* (Geneva, Switzerland, September 9-14, 1957); *Am. J. Psychiat.*, **115**, 865-72 (1959)
99. Riegelhaupt, L. M. Investigations of the urinary excretion pattern in psychotic patients. *J. Nervous Mental Disease*, **127**, 228-31 (1958)
100. Rinkel, M., and Denber, H. C. B. *Chemical Concepts of Psychosis* (McDowell/Obolensky, New York, N. Y., 1958)
101. Robie, T. R. Iproniazid chemotherapy in melancholia. *Am. J. Psychiat.*, **115**, 402-9 (1958)
102. Russek, H. I., and Zohman, B. L. Relative significance of heredity, diet and occupational stress in coronary heart disease of young adults. *Am. J. Med. Sci.*, **235**, 266-77 (1958)
103. Searles, H. F. Positive feelings in the relationship between the schizophrenic and his mother. *Intern. J. Psycho-Anal.*, **39**, 569-86 (1958)
104. Searles, H. F. The effort to drive the other person crazy—an element in the aetiology and psychotherapy of schizophrenia. *Brit. J. Med. Psychol.*, **32**, 1-18 (1959)
105. Scher, J. M. The structural ward: research method and hypothesis in a total treatment setting for schizophrenia. *Am. J. Orthopsychiat.*, **28**, 291-99 (1958)

106. Schmideberg, M. Values and goals in psychotherapy. *Psychiat. Quart.*, **32**, 233-65 (1958)
107. Shagass, C., and Jones, H. L. A neurophysiological test for psychiatric diagnosis: results in 750 patients. *Am. J. Psychiat.*, **114**, 1002-10 (1958)
108. Shagass, C., and Kerenyi, A. B. Neurophysiologic studies of personality. *J. Nervous Mental Disease*, **126**, 141-47 (1958)
109. Shagass, C., and Kerenyi, A. B. The "sleep" threshold: a simple form of the sedation threshold for clinical use. *Can. Psychiat. Assoc. J.*, **3**, 101-9 (1958)
110. Siegel, M., Niswander, G. D., Sachs, E., and Stavros, D. Taraxein: fact or artifact. *Am. J. Psychiat.*, **115**, 819-20 (1959)
111. Smith, C. M. A new adjunct to the treatment of alcoholism. The hallucinogenic drugs. *Quart. J. Studies Alc.*, **19**, 406-17 (1958)
112. Smith, C. M. *Psychosomatic Aspects of Narcolepsy* (Thesis, Doctor of Medicine, Univ. of Glasgow, Glasgow, Scotland, 1958)
113. Smith, C. M. Psychosomatic aspects of narcolepsy. *J. Mental Sci.*, **104**, 593-607 (1958)
114. Smith, C. M., and Hamilton, J. Psychological factors in the narcolepsy-cataplexy syndrome. *Psychosomat. Med.*, **21**, 40-49 (1959)
115. Smith, C. M., and Schneider, R. A. Narcolepsy and hypoglycemia. *J. Mental Sci.*, **105**, 163-70 (1959)
116. Smythies, J. R. Biochemical concepts of schizophrenia. *Lancet*, **II**, 308-13 (1958)
117. Sommer, R. Displaced persons: the elderly patients in a large mental hospital. *Geriatrics*, **13**, 653-61 (1958)
118. Stein, M. H. The cliché: a phenomenon of resistance. *J. Am. Psychoanal. Assoc.*, **6**, 263-77 (1958)
119. Stevens, J. M., and Derbyshire, A. J. Shifts along the alert-repose continuum during remission of catatonic "stupor" with amobarbital. *Psychosomat. Med.*, **20**, 99-107 (1958)
120. Stokes, A. B. Problems of schizophrenia. The metabolic and physiological survey of a case of periodic catatonia from illness to recovery. *Folia Psychiat. Neerl.*, **61**, 252-57 (1958)
121. Streifler, M., and Kornblueth, W. The effect of blood sera of schizophrenics on the glucose utilization by the rat retina. *Chemical Concepts of Psychosis*, Chap. 11, pp. 257-64 (Rinkel, M., and Denber, H. C. B., Eds., McDowell/Obolensky, New York, N. Y., 485 pp., 1958)
122. Strom-Olsen, R. Humoral changes in manic-depressive psychosis with particular reference to the excretion of catechol amines in urine. *J. Mental Sci.*, **104**, 696-704 (1958)
123. Thompson, C. Various methods of psychotherapy and their functions. *Am. J. Psychotherapy*, **12**, 660-70 (1958)
124. Turner, W. J., and Merlis, S. Effect of some indolealkylamines on man. *A.M.A. Arch. Neurol. Psychiat.*, **81**, 121-29 (1959)
125. Vanggaard, T. Neurosis and pseudoneurosis. *Acta Psychiat. Neurol. Scand.*, **33**, 251-54 (1958)
126. Vernon, J., McGill, T. E., and Schiffman, H. Visual hallucinations during perceptual isolation. *Can. J. Psychol.*, **12**, 31-34 (1958)
127. Walton, H. J. Suicidal behavior in depressive illness. *J. Mental Sci.*, **104**, 884-91 (1958)

128. Weakland, J. H., and Jackson, D. O. Patient and therapist observations on the circumstances of a schizophrenic episode. *A.M.A. Arch. Neurol. Psychiat.*, **79**, 554-74 (1958)
129. Weckowicz, T. E., Sommer, R., and Hall, R. Distance constancy in schizophrenic patients. *J. Mental Sci.*, **104**, 1174-82 (1958)
130. Weisman, A. D., and Hackett, T. P. Psychosis after eye surgery. *New Engl. J. Med.*, **258**, 1284-89 (1958)
131. Whatmore, G. B., and Ellis, R. M. Some motor aspects of schizophrenia: an EMG study. *Am. J. Psychiat.*, **114**, 882-89 (1958)
132. Whitaker, C., Bateson, G., Hayward, M. L., Jackson, D. D., Malone, T. P., Rosen, J. N., Taylor, J. E., and Warbentin, J. *Psychotherapy of Chronic Schizophrenic Patients* (Little, Brown & Co., Boston, Mass., 219 pp., 1958)
133. White, R. W. Abnormalities of Behavior. *Annual Review of Psychology*, **10**, 265-86 (Farnsworth, P. R., and McNemar, Q., Eds., Annual Reviews, Inc., Palo Alto, Calif., 520 pp., 1959)
134. Williams, E. Anorexia nervosa: a somatic disorder. *Brit. Med. J.*, **II**, 190-95 (1958)
135. Winter, C. A., and Flataker, L. Effect of blood plasma from psychotic patients upon performance of trained rats. *A.M.A. Arch. Neurol. Psychiat.*, **80**, 441-49 (1958)
136. Wolstenholme, G. E. W., and O'Connor, C. M. *Neurological Basis of Behavior* (J. & A. Churchill, Ltd., London, England, 400 pp., 1958)
137. Woolley, D. W. Participation of serotonin in mental processes. In *Chemical Concepts of Psychosis*, Chap. 9, II, 176-89 (Rinkel, M., and Denber, H. C. B., Eds., McDowell/Obolensky, New York, N. Y., 485 pp., 1958)
138. Wynne, L. C., Ryckoff, I. M., Day, J., and Hirsch, S. I. Pseudo mutuality in the family relations of schizophrenics. *Psychiatry*, **21**, 205-20 (1958)
139. Ziskind, E. Isolation stress in medical and mental illness. *J. Am. Med. Assoc.*, **168**, 1427-31 (1958)

PSYCHOTHERAPY^{1,2}

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In a field such as psychotherapy, beset as it is by powerful ego-involvements in methods and extreme difficulties in control and sampling in experimentation, progress is necessarily slow and halting. However, the past year has seen a number of significant attempts—theoretical, clinical, and experimental—to subject old beliefs about psychotherapy to sharp scrutiny and empirical test. These efforts have as their aim the improvement of the efficacy of therapeutic techniques, the analysis of values in our society, or contribution to the knowledge of personality dynamics or personality theory.

This review is divided into three major sections: the first deals with general contributions to the theory and practice of psychotherapy; the second with clinical reports; and the third section with research in psychotherapy. In the selection and analysis of contributions reviewed here, major emphasis is placed on research contributions and in broader, more general contributions to the theory underlying or supporting various therapeutic methods.

GENERAL CONTRIBUTIONS TO THE THEORY AND PRACTICE OF PSYCHOTHERAPY

Psychoanalytic therapies.—It is still abundantly clear that the center of the stage is being held by writers who attach to themselves the label psychoanalytic, psychoanalytically-oriented, or modified psychoanalytic in describing their method of treatment. While this is so, the term psychoanalysis itself appears to have less precise meaning with each passing year, and the use of the term leads to increasing obfuscation and confusion. Psychoanalysis is apparently a belief about some facts of behavior, a theory of personality, a theory of biology, a method of treatment, and, according to Fromm (31), a sociopolitical philosophy. One individual attacks psychoanalysis from a stand which he refers to as rational therapy, while his position is being assailed by someone else who refers to it as psychoanalytic. A modern theorist who refers to himself as psychoanalytic is referred to by others as neo-Freudian, neo-Adlerian, and, sometimes, as an independent thinker. As a result, specific contributions reported in this section will be based on what the authors call themselves rather than a classification on the basis of either theory or specific technique.

An example of this kind of confusion in terminology is provided by a

¹ This review covers the period of April, 1958, to April, 1959.

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survey of 298 child-therapy outpatient clinics completed by Filmer-Bennett & Hillson (26). To mailed questionnaires, they obtained 40 per cent replies. In asking what kind of treatment was used at these clinics, 75 per cent of the respondents described themselves as subscribing to psychoanalytic principles but very few of these apparently actually followed classical Freudian (Anna Freud or Melanie Klein) methods. The specific authority most frequently followed was Frederick Allen, who has always spoken for a method of treatment which deals only with the present and has usually been characterized as Rankian or relationship therapy.

Theory of Psychoanalytic Technique, a recent contribution of Menninger (71), will be welcomed by most practitioners of what may be called relatively orthodox psychoanalytic therapy. In his book, Menninger appears to hew fairly closely to the line set by Freud. Although called a theory of psychoanalytic technique, to the reviewer it appears more properly a therapy manual, justified primarily by the author's experience and by the statements of Freud, and only sometimes including a rationale for specific aspects of treatment at what might truly be called a theoretical level. The primary emphasis of the book revolves around the psychodynamic character of the interplay between patient and therapist, with the beginning of therapy seen as a contract between patient and therapist. Maximum emphasis is placed on the importance of transference, resistance, counter-transference, and the other aspects of patient-therapist interaction. Perhaps one of the most valuable aspects of this book, at least to the less-experienced therapist, is a list of signs indicating when countertransference is interfering with therapeutic aims. The signs are, in fact, reminders that something is amiss, and the list should be useful for both experienced and inexperienced therapists alike, to be read over regularly during the course of each case.

A briefer contribution to the theory of psychoanalytic treatment is presented by Alexander (2). For the most part, Alexander's contribution is traditional, but it follows the trend of ever-increasing emphasis on the patient-therapist interaction and the establishment and analysis of the transference, with less emphasis being placed on the cleaning-out of the unconscious. Alexander broadens the concept of transference to include, not only the transference of crucial attitudes and reactions from parents to therapists, but also siblings and significant others. By implication, he increases the emphasis on the importance of siblings and others in the significant experiences of childhood. Alexander also feels that a neglected aspect of psychoanalytic technique is an understanding of the nonverbal communication or interplay between therapist and patient. He believes the whole therapeutic process needs to be exposed to greater objective study by others, asking the therapist to be willing to expose himself so that there is a greater opportunity to learn more about the therapeutic process.

A somewhat different contribution is provided by Saul (97). In his *Technique and Practice of Psychoanalysis*, Saul covers much the same ground as Menninger, but with a distinctly different theoretical flavor.

In his discussion, Saul lists 10 of the "outstanding advances" resulting from recent progress in psychoanalysis. All of these have in general an Adlerian flavor, although they are sometimes attributed to Freudian formulations which have been little recognized. Among these are, for example, a placing of central importance on the concept of dependence and the separation of the concept of love from sexual feelings. Some of these which are more clearly Adlerian in origin are quoted below (pp. 37-38).

The ego has been the subject of increasing studies which have broadened psychoanalysis in many ways, made it more realistic and deepened it. Even indisputable sexual material and symbols are often seen to have ego meanings.

Cognizance of the ego and of the realities of a freely competitive civilization make obvious the importance in life of strivings for status and prestige and show the pain of inferiority feelings and loneliness.

The above points list dynamic motivational forces, not constellations or objects of them, but there should be included increasing recognition of the vital importance of the mother-child relationship and also, in many cases, of the relationship with siblings.

What difference do these theoretical advances make in Saul's treatment procedures? Although the analysis of the transference is still the central aspect of treatment, some changes from more orthodox psychoanalysis are suggested. One of these called for is a more active role on the part of the therapist; a second is less frequency of visits. The problem of dependence on the part of the patient is accepted as a more significant issue, and leads to a somewhat different handling of the transference relationship. The most significant change, however, is in the content of discussion and interpretation. Much more emphasis is placed on such ideas as inferiority feelings, hostility, dependency, and sibling rivalry with much less on sexual problems, sexual symbolism, resolution of the Oedipus complex, etc.

This book is a clear exposition of an orientation toward a method of psychotherapy. It will undoubtedly be of great value to practitioners of psychotherapy. The chapter on failures—legitimate and illegitimate—in particular stands out, not only for its negative, but for its distinctly constructive implications. Not only does this chapter express some of the limitations of a given method, but it points up a general need for flexibility and the suiting of the method of treatment to the particular patients involved.

Interestingly enough, although Saul's deviation from orthodox Freudian theory is distinctly in the direction of Adlerian theory, with many specific references to inferiority feelings, sibling rivalry, dependency, the importance of love for others, etc., not a single reference is made to Adler. Of course, this is no surprise. Theorists for the last 20 years have been writing books re-expressing many of Adler's concepts without reference to Adler, although sometimes twisting and turning considerably in order to prove that these ideas were accepted by Freud. This phenomenon, of interest in the sociology of knowledge, is taken up by Fromm (31), in *Sigmund Freud's Mission*.

In some ways, Fromm's essay is a commentary on Jones' recent biog-

raphy and must be intended, at least in part, as an antidote to Jones' "idolatric picture of Freud." Fromm is interested, however, not only in an abstract essay on the sociology of knowledge and Freud's influence on society, but also in what he perceives as specific limitations and erroneous values that are part of psychoanalytic doctrine, and which, he feels, derive from specific defects and distortions in Freud's own character.

Specifically, Fromm makes much of Freud's "coldness." He sees Freud as lacking in love for others, deprecating the role of women, being sexually inhibited, and highly egocentric. Because of this, he sees the whole Freudian movement as avoiding joy and pleasure, choosing, rather, as its aim the control of all passions. He also sees Freud as politically conservative, nationalistic, and authoritarian. As a result, psychoanalytic theory has lost its character as a scientific theory and has become instead a "movement." The following quotes give the flavor of Fromm's analysis.

Is there any other case of a therapy or of a scientific theory transforming itself into a movement, centrally directed by a secret committee, with purges of deviant members, with local organizations in an international superorganization? No therapy in the field of medicine was ever transformed into such a movement (p. 82).

But aside from the relative sterility of the "official" psychoanalytic thought, its dogmatism is manifested in its reaction to any deviation. One of the most drastic examples, I have already given—Freud's reaction to Ferenczi's idea that the patient needed love as a condition for his cure. This only emphasized what was and is going on everywhere in the movement. Analysts who criticize Freud's ideas explicitly, frankly and publicly are considered as outside the fold, even when they have no intention of founding "schools" of their own, but only set forth the result of their thinking and observation based on those of Freud (p. 107).

From a forward-moving and courageous idea, psychoanalysis became transformed into the safe credo of those frightened and isolated members of the middle class who did not find a haven in the more conventional religious and social movements of the time. The decay of liberalism is expressed in the decay of psychoanalysis (p. 112).

In sum, then, Fromm has two major points to make. One is that the values inherent in the aims of psychoanalytic therapy are middle-class values of control rather than those stressing love, joy, and pleasure. Secondly, psychoanalytic theory has been hamstrung by political characteristics and authoritarian overtones which make for the rejection of deviators and for fear of deviation.

Perhaps one minor example of the kind of thing that Fromm was discussing is provided in an article by Frank (29), who provides a discussion of the theory and treatment of neurosis in which it is obvious that he wishes to place a great deal more emphasis on the concept of dependency, which he refers to as pre-Oedipal in origin. He feels that the content of analysis should deal to a greater extent with infantile dependency (basically an Adlerian contribution), but finds it necessary to treat this as "an extension of libido theory," again invoking "neglected aspects" of Freud's writing.

Another major contribution to the practice of psychoanalysis is provided by Ekstein & Wallerstein (21) in a comprehensive book, *The Teaching and*

Learning of Psychotherapy. This book is written more or less from the point of view of the supervisor but is concerned with the interaction of the supervisor and his student therapists. It provides a thorough discussion of administrative problems of this relationship in the functional clinic setting and some of the general problems the supervisor must resolve before taking on his task. One of these is the question of orthodoxy of approach versus openmindedness. Ekstein & Wallerstein have resolved this by advocating an orthodox approach, feeling that the student therapists must master this first; at the same time, however, the students are helped to keep their minds open. The method of treatment is psychoanalysis (presumably relatively orthodox). Although much of the material is specific to this method of treatment, much of it will be of interest and value for both beginning therapists and beginning supervisors of all orientations.

The supervisor-therapist interaction is described as different from psychoanalysis, but the same flavor is present. The supervisor is therapist—the therapist is patient—and there is apparently little room for didactic teaching or intellectual discussion. The important thing is to analyze the therapist's resistances and attitudes toward learning. Of course, the therapist's attitudes toward the patient in therapy also come under examination, but the supervisor is "in error" when he approaches these problems too directly, and he must deal with the therapist as the therapist must deal with the patient. Ekstein & Wallerstein recognize the problem of didactic teaching vs. therapy as a method of supervision. They feel that some middle ground is desirable, although it is the reviewer's opinion that they find this ground much closer to the therapy end of the continuum. They still, however, feel that there is a basic difference between the "goals of the process" in supervision and in psychotherapy. There can be little quarrel with the value and effectiveness of the methods they suggest in helping the therapist see the intrusion of his own personality and feelings in the psychotherapy he practices. On the other hand, the method described runs the same danger as the personal analysis of predicating the learner's beliefs about theory and technique, in part, on the satisfactoriness of his relationship with his therapist or supervisor. And, of course, the old question can be posed: The supervisor analyzes the countertransference of the therapist, the consultant analyzes the countertransference of the supervisor, but where does it all end?

The trend towards increased importance of the ego in psychoanalysis is also exemplified by Slavson (102). He provides a "bio-quantum theory" of the ego and its application to group psychotherapy. His major point is that the ego is comprised of instincts which are separate and apart from the id instincts. The ego instincts provide more than the forces that carry into action the wishes of the id. All education and socialization of the human personality depend upon the native instincts of the ego. Group psychotherapy must give more attention to modifications of the ego.

Client-centered psychotherapy.—Rogers (85, 86) has contributed a new discussion to the understanding of psychotherapy. This is "a very tentative

continuous scale for the understanding of the flow of psychotherapy." He feels that such a continuum may apply to the "whole spectrum of personality change and development and not to psychotherapy alone." The model describes seven stages in the individual's experiencing. Rogers makes clear that the seven stages are a more or less arbitrary number of discriminations of a continuous process. He also refers to these stages as "strands of flow" which intertwine and integrate in the mature, healthy organism. The self, feelings, and internal conflict are still the basic variables with which Rogers deals. To some extent, this new formulation borrows from Kelly's personal construct theory and from the existentialist movement. It is hard to see how these somewhat vague and relatively insubstantial formulations will be useful in any general way in describing personality change or change in psychotherapy as it would be conducted by anyone other than a client-centered therapist. Even in the latter case, although clinician's judgments about stages can be obtained with low reliability, it is difficult to see what can be accomplished other than the correlation of such clinician's judgments with therapist's judgments about the success of psychotherapy obtained with the same bias, or correlations of clinician's judgments with time or age.

Lebo (62) discusses the application of client-centered play therapy to individual treatment of children. He feels that the method is too inflexible and that there is an absence of necessary constructs to describe differences in children which should be reflected in differences in treatment. By way of illustration he discusses age and aggression as examples of variables which require modification in treatment method if the cases are to be helped in therapy.

Learning-theory approaches.—The major contribution of the past year from a learning orientation is that of Wolpe (120), who has described his technique "therapy by reciprocal inhibition."

Wolpe, who was previously a psychoanalytic psychiatrist, has rejected the Freudian approach and describes a method of treatment which he has based on his understanding of psychophysiology and current behavior theory, particularly the work of Hull. His basic paradigm is as follows: fear or anxiety, as unlearned autonomic responses, becomes attached by the conditioning process to neutral stimuli or to what he calls pervasive stimuli. A conditioned anxiety results which is attached to the neutral stimuli. The anxiety condition itself may be the basis for the complaint, or the basis of the complaint may be the behavior which has been learned to reduce the anxiety, such as drug-taking, alcoholism, or obsessions. The principle of reciprocal inhibition is

... if a response antagonistic to anxiety can be made to occur in the presence of anxiety-evoking stimuli, so that it is accompanied by a complete or a partial suppression of the anxiety responses, the bond between these stimuli and the anxiety responses will be weakened (page 71).

Therapy consists of getting the patient to understand that his reactions or maladaptive behavior result from persistent fear responses that occur too

often or too strongly, or to unadaptive stimuli. Other ways of responding to these stimuli are provided by the therapist. Suggestion, hypnosis, relaxation, and desensitization are relied upon extensively as methods of getting the patient to substitute new responses. Wolpe reports rather remarkable success in treatment by his methods, claiming 90 per cent "apparently cured," which he compares with the approximately 50 per cent as typified by psychoanalysis, this in spite of the fact that his methods require a much shorter average number of interviews.

To this reviewer, there does not appear to be any clear or strong connection between Wolpe's theory and his practices. The learning theory he puts forth seems to be oversimplified for the data he is dealing with and, to some extent, outmoded. It does seem clear, however, that, in spite of the weaknesses in Wolpe's criteria for improvement, change, or cure, he is able to obtain reduction of symptoms and lasting and beneficial change in many cases with his methods. Short-term psychotherapy by a therapist who accepts and wants to help his patient and who has a strong belief in the efficacy of his methods may well produce as much therapeutic change, or more, as do the longer and more esoteric techniques.

A brief report on the use of reinforcement and generalization techniques in the treatment of children's problems is contributed by White (115). He discusses the general applicability of these concepts, illustrating with a description of the treatment of a feeding problem.

Other approaches.—Perhaps the greatest stir in this field of the past year has been created by a group of writers who ally themselves with a movement which they call "existential analysis." It is not easy to conceptualize briefly this orientation, but the point of view has been extensively explicated in a recent book edited by May, Angel & Ellenberger (69). Apparently, existential analysis is not so much a specific method of treatment as it is an application of a philosophy regarding the nature of man and the place of psychotherapy in society. It draws on Kierkegaard, Heidegger, and Nietzsche in philosophy. Its modern psychotherapy practitioners, who may be considered leaders of the movement, are Binswanger and Minkowski. The specific method of treatment is not as important as the goal of therapy, which perhaps can be loosely stated as man's recapture of himself. In theoretical analysis the movement attempts to eliminate the cleavage between subject and object, and between man and his environment. Presumably, it deals with man as "being" or "becoming," although it is not clear to the reviewer what the specific implications of this viewpoint are, or why it is that other points of view apparently do not recognize these characteristics of their human subjects.

The technique of psychotherapy is not too clearly defined, but the philosophy of treatment stresses the view of the patient from within the reality of his own perceptions and actions. Treatment must avoid the stereotyping of the patient into fixed theoretical models and the projection of the way in which the therapist, not the patient, sees the world. Apparently the proponents of the movement feel that psychoanalysis falls into the latter error

and is overly scientific. However, some of the techniques of psychoanalysis may be used in actual treatment. Although the method and philosophy of existential analysis are seen as growing out of phenomenology, it differs from phenomenology in that it deals with the unconscious life and uses historical techniques.

Hora (46, 47) has written about existential group psychotherapy. He stresses therapy as a living experience, placing great emphasis on the concept of "letting be." The object of psychotherapy is the attainment of authenticity of being. It is a living experience. The binding force in group psychotherapy is essentially affective, and the affective forces must be shared by the group.

In Hill's (44) discussion of existential group psychotherapy, the role of the therapist is emphasized.

The therapist needs to be free of those inhibitions and compulsions, those reaction formations and denials which prevent a spontaneous expression in word and deed of his understanding and judgment of the patient's inner and outer difficulties . . . "

In spite of the heavy reliance on value-laden terms, with obscure referents, this movement can be seen, at least in part, as a reaction to stereotyped approaches to people, "canned" interpretations, psychiatric labels, and rigid techniques. The technique of psychotherapy advocated calls for a more individualized, spontaneous, flexible and nonclassificatory approach. Although it is not clear whether it is in effect antiscientific, in the sense that antiscientific is conventionally understood to mean to psychologists, its positive contribution is too obscure to be discerned by this writer.

Wolf & Schwartz (119) have reacted strenuously to what they see as a new trend in therapy toward the mystical. They attack the new "irrational psychotherapy" as an appeal to unreason. As examples of this dangerous trend, begun on the Continent but now finding its place in America, they include a revival of interest in the "mysterious, semireligious concepts of Jung," an interest in Hindu philosophies and Zen Buddhism, and existential analysis. Although the authors' criticisms may be well-founded, there is some question in the reviewer's mind whether such approaches are actually on the increase, or whether they are constantly reappearing under new guises.

While existential analysis criticizes psychoanalysis for being too scientific and rational, Ellis (24) criticizes the same doctrine for being too unscientific and mystical. Ellis feels that the neuroses are to a large extent based on major fallacies of the patient. Some of these fallacies are idiosyncratic, some cultural. Ellis feels that the patient can learn to think rationally and control his irrational emotions. The method by which this is accomplished is presumably that of active interpretation on the part of the therapist. Apparently without being aware of it, Ellis is reformulating Adler's notion of "common sense." He does, however, feel that not all can benefit from such an approach, some patients being too disturbed and some insufficiently intelligent. In another article (23) he describes the use of hypnosis, apparently as an adjunct

to rational therapy. Direct suggestions are made under hypnosis, not for cathartic purposes, but suggestions as to how the patient should react in given situations.

In another discussion of the use of hypnosis, Barber (5) reviews some of the current theories, attempting to reconsider hypnosis, not as an entity or special state of mind, but as a special problem, or one aspect of the psychology of belief and perception.

Boileau (10) describes a new technique of brief psychotherapy which he calls "need integrative therapy." Directly opposite to Ellis, he does not take the attitude that the patient is mistaken, or a victim of misunderstanding, but that his needs are normal and his neurosis is an expression of natural needs. It is the patient's best effort under provocative circumstances. The treatment involves reassuring the patient of this and, consequently, supporting him. To the reviewer, it appears that the method should be very attractive, but dangerous, to highly narcissistic and blame-projecting patients, and that it would help reinforce the "neurotic" behavior of many.

Murphy (74) discusses the characteristics of what he refers to as "dynamic psychotherapy" in contrast to psychoanalysis. Dynamic therapies are characterized by the absence of the development of the transference neurosis. The therapist tends to be much less of a neutral figure and the psychotherapy is oriented primarily toward symptom removal or reduction. According to Murphy, dynamic therapy lacks substantial theoretical underpinnings. Dynamic therapy and psychoanalysis are clearly dissimilar. However, Thompson (108) feels that the differences in dynamic, neo-analytic, existentialist, and psychoanalytic methods are superficial. All the methods deal with Freud's main theories and concepts.

Sakel (92) attacks the rigidity of the Freudian orientation, claiming that Adler's "individual psychology" is the more flexible approach in that it varies with the needs of the individual.

Papanek (77) discusses group psychotherapy from an Adlerian viewpoint. She feels that the . . . "dynamic cohesiveness of the group is based upon the predominance of the values of equality, honesty and social interest." Changes in ethical values and the internalization of group standards accompany the emergence of a healthier personality.

An interesting challenge to psychotherapists has been suggested by Rosenthal (88). Rosenthal discusses the many problems of aging, from the onset of the dangerous forties to retirement age. He maintains that, for many people, age itself is used as an excuse for maintaining a poor adjustment to life problems. On the other hand, psychotherapists have built up stereotypes about the difficulty of changing such patients or of treating them by intensive psychotherapy. Rosenthal points out that no extensive research has been done on the likelihood of good response in the treatment of older subjects. The negative stereotypes have been built up on the basis of both flimsy evidence and, possibly, a failure to adapt psychotherapeutic techniques flexibly to the needs of the patient.

The general concern with patient-therapist interaction has led to increased interest in the concept of communication. Greenhill (38) and Barbara (4) have contributed discussions of communication in which they make the focal concept in psychotherapy by reinterpreting characteristic aspects of psychotherapy in terms of communication. Greenhill sees that the end goal of therapy is the development of a person who, through the freedom of his communication, can contact other humans and, consequently, work out a tolerant and accepted interpersonal relationship. Barbara feels that the communication of self leads to a process of liberation toward self-realization. "The final word must belong to the patient."

Values and ethics in psychotherapy.—An increased interest both in expressed values of the psychotherapist and in implicit values involved in his methods has been evidenced during the past year. The previously cited work of Fromm and the existential analysts illustrates one aspect of this trend. Part of the concern follows from a newer understanding that the therapist cannot really keep his own values out of the psychotherapy interaction. Both by his choice of method and by his own verbal and, sometimes, nonverbal behavior, he tends to be impressing a particular set of values on the patient. Watson (113) provides one discussion of this assertion, rejecting the solution that the therapist only provides insight or mirrors the patient's feelings. Amoral psychotherapy he feels is a contradiction in terms, and each therapist must grapple with the problem of his own values.

A similar discussion is contributed by Patterson (79), who reviews a number of studies indicating that the therapist cannot keep his values out of therapy. For Patterson, the solution is for the therapist to be aware of these values when he is expressing them so that he can clearly label them as his own, leaving the client free to accept or reject them. He feels that such a solution will reduce or eliminate the therapist's influence on the patient's values. The client-centered therapist leaves it to other social institutions to inculcate ethical values. However, it is difficult to see how such overt statements (that particular values are typical of the therapist, but that the patient does not have to accept them) will not have a heavy influence on the patient, assuming a positive relationship exists between the patient and the therapist and that the patient feels that he has gained something in psychotherapy.

Papanek (78) points out that normal behavior requires the acceptance of certain more or less specific ethical values which influence, direct, and motivate behavior. Psychotherapy cannot ignore these nor avoid the issue in helping the patient find a normal adjustment. The author relies on the concept of social interest to solve this problem. By affirming that man has a natural aptitude for socially oriented behavior, she feels that Adler provided a basis for the introduction of ethical values into psychotherapy.

A major contribution to the understanding of the relationship between implicit values and psychotherapeutic techniques is contributed in a recent book by Glad (35). Glad attempts to show how the basic methods of Freud,

Jung, Rank, Sullivan, Rogers, etc. follow from the kind of person which is valued by each of them. The implicit or explicit notion of the well-adjusted or good man determines to a large extent the method or technique of treatment and the evaluation of improvement and cure.

Whitehorn (116) specifically presents the relative merits of what he considers to be the two major value systems of psychotherapists. One value system places high preference on the therapeutic goals of freedom, the other on the therapeutic goals of conformity. Although he confesses a personal bias in favor of freedom, Whitehorn recognizes the justifications for a conformity-oriented (adjustment) approach to psychotherapy.

While Whitehorn takes a judicial role in relationship to these two value concepts, Sager (91) comes out freely and strongly for freedom in psychotherapy. Crediting Fromm for pointing out the importance of freedom in psychotherapy, Sager goes on to explicate its role in the patient's internal adjustment and also in his relationship to society. Any concept of freedom in psychotherapy cannot be divorced from the political, economic, academic, and philosophical aspects of freedom. In a general way, conventionality and conformity to immediate social groups as a goal of therapy can be differentiated from a goal stressing the individual's relative independence of immediate social groups in favor of other values such as freedom from internal conflict, creativeness, achievement, social contribution, etc. It is apparent, however, that the term freedom, like democracy, has taken on many meanings for many people, and has been made so general that it is of doubtful utility. It has accumulated more positive value tone than it has clarity.

The values of psychotherapy in their relationship to religious goals have also constituted an area of interest for psychotherapists. A group of Lutheran educators (111) discussed the role of the psychotherapist, and his concept of man in general, and, more specifically, the responsibilities of the pastoral counselor. A discussion of a somewhat similar nature is provided by Walters (112), who feels that science provides only a truncated view of man. He feels that the fact that psychotherapy is usually set in a context of naturalism and positivism need not be so, and that psychotherapy can go beyond the positivistic to include discussions involving metaphysics and religion.

Bergman (8) discusses the possible role in psychotherapy of faith in the religious sense, including faith in psychoanalysis. He feels it provides a potential power for cure that is strong but is not safe to use since it may lead to extremes which may hurt others and, eventually, the patient. Ekstein (20), commenting on Bergman, expresses the belief that faith, itself, can be treated as a rational scientific variable and can eventually be utilized in psychotherapy.

CLINICAL REPORTS

This section includes case reports, discussions of treatment of particular kinds of cases, and discussions of specific aspects of psychotherapeutic technique. For the most part, the articles in this section have been included for reference purposes and are treated briefly and uncritically.

Individual psychotherapy with adults.—Thorne (109) discussed structuring in eclectic psychotherapy. He provides examples from typescripts of a variety of cases, illustrating with examples of structuring in treatment. Morse (73) examines the problem of psychotherapy with nonreflective and aggressive patients. Two case histories are described in which no attempt was made to develop insight in the patient. Identification with the therapist and the introjection of his standards of behavior can be the vehicle for such therapy. The author advocates a pool of therapists, permitting easy transfer from one therapist to another to meet the needs of the individual patient more effectively. Blaine & McArthur (9) raise the question of whether the therapist does, in effect, unlock unconscious material. Rather, in many cases, the therapist provides an objective reference for the patient to discuss the problems of his past experience in an attempt to discover what has actually happened to him.

Orgel (76) reports on therapy with peptic ulcer cases. He feels that five unsuccessful cases were due to the patients' failure to pursue their psychoanalytic treatment to its conclusion; 10 cases who did were successfully treated.

The problem of treatment of homosexuals is taken up by Rubinstein (90). He feels that the best psychotherapeutic bets are the "neurotic" homosexuals who are not aware of their fears; patients who genuinely want to be women are less likely to respond to psychotherapy. Many valuable cultural pursuits are closely related to homosexual activity. He feels that complete psychoanalysis is the treatment of choice, and the goals of therapy are spontaneous sublimation, strengthening of the ego, and diminishing of anxiety and repressions which bar creative expression and creative love.

The treatment of schizophrenia is the subject of a number of contributions. Fromm-Reichman (32) discusses the problems of making interpretations and the problems of countertransference. Will (117) describes his extensive experience in psychotherapy with schizophrenics, emphasizing that the process of psychotherapy takes place in a social field of the family and other interpersonal relationships. Heath *et al.* (41) believe that schizophrenia is a genetically determined, metabolic disease, and that psychotherapy is limited. Psychotherapy cannot remedy the basic defect, but, at best, can provide a leaning post for the patient to help him meet life situations.

Gruenthal (39) tends to agree. He feels that schizophrenics are never cured in the medical sense, but psychotherapy can help them to function unobtrusively and to live constructive lives, provided that the outer circumstances are favorable. His approach is one of active guidance, which he feels should proceed subtly and be administered with great patience.

Brody (14) emphasizes the learning of new perceptual responses in the schizophrenic patient. The therapist begins by being a representative of a group of people; later he is responded to as an individual. As the patient acquires the ability to analyze and communicate to the therapist, he tentatively acquires new responses which are reinforced by the reduction of tension and

anxiety. Searles (99) discusses his belief that the schizophrenic is particularly characterized by his reaction to the therapist's unconscious processes. The treatment of schizophrenics tends to call for a higher degree of self-awareness on the part of the therapist.

McKinnon (70) illustrates Rosen's method of "direct analysis." The method involves the direct interpretation of the unconscious life of the patient and the development of an intense emotional involvement on the part of the therapist and patient. This emotional involvement allows communication with the patient and a breakthrough of autistic preoccupations.

Individual psychotherapy with children and adolescents.—Miller (72) discusses family interaction in the therapy of adolescent patients. He emphasizes treatment of the whole family, not only to provide an optimal environment for the patient, but also to expedite treatment. Ackerman (1) puts it more strongly, pointing out the limitations of individual psychotherapy. The therapist must take into consideration the whole family situation, and individual and group treatment of the whole family is advocated. The problems of personality organization and integration are cast into a mold of group living.

Psychotherapy with adolescent girls in a court clinic is described by Sherman (101). He believes it important to focus on the immediate surface problems which have brought the girl to the court and states that his experience indicates that these patients can improve their adjustment by developing defenses against deeper unconscious problems. In general, the technique is one involving a cathartic working-through of surface problems and the direct encouragement of subsequent defenses.

Weigert (114) discusses the treatment of children who are still unskilled in verbal self-expression. Nonverbal communication is of extreme importance, and transference, both positive and negative, is based upon such communication. The dissolution of transference opens the way to the meaningful communication of mutual partnership.

Group psychotherapy.—For the most part, the contributions in group psychotherapy have involved reports of experience with special problems and particular groups of patients. The extension of existential analysis to group psychotherapy has been referred to earlier.

Beard, Goertzel & Pearce (7) discuss the effectiveness of activity group therapy with regressed adult schizophrenics. They feel the participation of the patient in some project at a reality level with others promotes a process of restitution of lost ego capacities. Winder & Hersko (118) have analyzed the themes produced in group discussion for a group of eight psychoneurotic veterans. They feel that the themes appear in a regular and orderly manner. The problem of the suicide of a member in a group during the course of treatment was discussed by Bowers, Mullan & Berkowitz (13). They describe two actual instances and list a number of recommendations for handling such a situation, based on their experience.

Group therapy experiences with alcoholics and addicts have been de-

scribed by Battagay (6), with religious personnel by Bowers, Berkowitz & Brecher (12), and with medical students by Ganzarain, Davanzo & Cizaletti (33), both of the latter being in psychiatric training.

Special problems of group psychotherapy with homosexuals are described by Hadden (40). Hadden feels that overt homosexuals should be treated in a group (as the method of choice) which exclusively consists of homosexuals. One patient's rationalization that homosexuality is a pattern of life he wishes to follow is attacked by other members of the group.

MacDonald (65) analyzes an unsuccessful attempt to treat the wives of institutionalized alcoholics. He feels that failure of the group was the result of the therapist's failure to control the group anxiety stirred up by one member.

Several assessments of programs of group psychotherapy have been published. Kräupl-Taylor (57) discusses the history of the development of group administrative therapy in Great Britain. Phillipson (81) reports on the progress of a two-year program of psychotherapy involving 21 groups. Two practical conclusions were that groups with adult patients between 25 and 35 years of age do better than groups with patients whose ages are over 35, and that groups with a narrower age range do better than those in which the age range is more than 10 years. Pine, Gardner & Tippet (82) describe a program of short-term group psychotherapy in a hospital setting. Kotkov (55) discusses the favorable and unfavorable clinical indicators for group psychotherapy.

Experience with an extended program of group psychotherapy for institutionalized delinquents is described by Shellow, Ward & Rubinfeld (100). Kaldeck (51) reports on a similar program of group psychotherapy for mentally defective institutionalized adolescents and adults. He feels that since insight is limited, group therapy is the treatment of choice, and that dynamically oriented psychotherapy has to be modified with this group to include some "repressive-inspirational" features.

Jones (50) compares a warm, permissive atmosphere in group psychotherapy with institutionalized children to an atmosphere more oriented towards the setting of standards and limits of behavior. He concludes that the warm, permissive atmosphere leads to better adult-child relationships, which are crucial for the group.

Group therapy with stutterers and their mothers is described by Schneer & Hewlett (98). Therapy is based on a psychological interpretation of stuttering. Ginott (34) supplies a theoretical analysis of play group-therapy for younger children. He feels that the course of successful treatment runs from displacement to sublimation.

RESEARCH IN PSYCHOTHERAPY

Experimental investigations of psychotherapy are difficult and time-consuming. The more sophisticated the investigator the more elaborate and difficult his experimental designs. Nevertheless, research in psychotherapy is being conducted at what appears to be an ever-increasing rate.

The difficulty revolves around the fact that there are four major variables involved in any study of psychotherapy. To study any one of these, the other three must in some way be controlled, and to study them all or any two of them in interaction involves an elaborate design. One set of variables has to do with the nature of the patient or patients. Methods that may work with one patient will not work with another. The effects of delay in treatment or therapist characteristics on one patient may be different from the same effects on another. The personal characteristics of the therapist provide an important set of variables in treatment. His experience, his personality, his theoretical orientation, etc. have all been related to other dimensions in psychotherapy, and the problem of generalizing results obtained with any one therapist or small group of therapists is a great one. The method of treatment involves a third set of variables. Generalizations about the relationship of particular therapist's characteristics and patient behavior cannot be extended from one method of treatment to another. Finally, there is a set of variables involving the criteria for change, outcome, improvement, or cure. What is considered positive gain, or improvement, from one theoretical orientation is rejected from another. Objective criteria like symptom removal are not universally accepted; nor is the patient's or therapist's own statement of relief from feelings of anxiety, tension, or conflict. Studies, therefore, of the relative efficacy of one method over another can hardly be meaningful until criterion measures of change are agreed upon and to some extent made uniform.

In addition to the difficulty of setting up adequate controls, there are the problems of measuring instruments and of isolating the crucial variables involved in controlling those parts of an experiment which are not intended to vary. For example, what are the dimensions which are important in describing two groups of patients as similar or equivalent? What are the dimensions which are important to measure in order to know that two groups of therapists are equivalent? What tests or other objective measures can be used to determine the degree of change, improvement, or cure? In the investigations of aspects of method or process, how does one measure such variables as depth of interpretation, warmth of therapist, acceptance, reassurance, patient anxiety, patient hostility, or patient insight? Because of this complexity and difficulty many of the studies are limited in the generalizations that can be made from them, and they fail to meet the criteria for clean-cut experiments typical of some laboratory research. However, it is clear that progress is being made, and the possibility of research investigation of psychotherapy for both practical and theoretical purposes looks brighter all the time. Investigations to be reported below are divided into five rather natural categories. These are studies of: therapist variables, patient variables, process variables, treatment outcome and improvement criteria, and experimental or laboratory analogues to psychotherapy.

Therapist variables.—Strupp has published two more of his studies of therapist behavior. In these studies, the therapist watches a sound film of an interview. At specific points in the interview the film is stopped and the thera-

pist is asked what he would do. The therapist also rates the patient on prognosis, liking, and other variables. One study (106) compares 55 psychiatrists and 55 psychologists matched for length of experience and personal analysis. He finds little difference between groups, with a slight tendency for psychiatrists to ask more exploratory questions and for psychologists to reflect more. In both groups greater experience was to some extent associated with more warmth and with statements of poorer prognosis for the patient. A second study (105) compares 14 Rogerian with 64 analytic-eclectic psychotherapists. Although there were many differences, there were few surprises. Generally, the Rogerians were more disinclined to make treatment plans or state therapeutic goals other than that of self-acceptance. For these client-centered therapists, prognostic estimates were more favorable, as was the stated attitude toward the patient. Although these studies are highly interesting and have an obvious advantage in controlling many aspects of the psychotherapy process, there is still unanswered the question of the relationship between these verbalized statements and attitudes and the actual behavior of the therapist with patients. Although the patient variable is controlled in that it is the same for all therapists, there remains the question of whether the differences between therapists would be maintained for different kinds of patients. Perhaps both of these limitations can be eliminated by future research.

A stimulating study on countertransference has been reported by Cutler (16). Operating on the theory that countertransference can be defined as a distortion of reality because of the unconscious needs and conflicts of the therapist, Cutler compared self-ratings vs. ratings of others as a criterion for conflict for two therapists. He then measured the amount of therapeutic distortion by the degree of deviance of the therapist's perception of what happened in therapeutic interviews as compared to the judgments of others. Judges also rated whether or not the patients' statements in areas of conflict were followed by ego-oriented or task-oriented responses by the therapist. Since the study involved only two therapists, generalizations cannot readily be drawn. It is interesting that the therapist who had been personally analyzed and had more experience did not distort, according to the judges, less than the other therapist. The study is of more value for its suggested methodology than for the conclusions that can be drawn from it. Although it is generally assumed that such distortion, or ego-oriented vs. task-oriented responses, is detrimental to therapeutic goals, this assumption must also be tested.

Fey (25) has investigated some correlates of experience and theoretical orientation of 36 therapists. Divided into four groups, his numbers are small, and his results not to be considered stable. He found Rogerians to be the most homogeneous, and his psychoanalytically-oriented least homogeneous. The other two groups, young eclectics and older eclectics, formed his basis for comparison of the effect of experience, although it is doubtful that the two groups could be considered to be equivalent on everything but experience.

His findings, in any case, were that greater experience led to greater flexibility, flexibility being defined as less inclination to respond with extreme views to the 30 questions about technique which he posed.

Holt & Luborsky (45) have described in full detail their attempt to predict the over-all competence of psychiatric residents. One of the criteria of effectiveness was skill in psychotherapy. In general, prediction was at a low level. There emerged no clear-cut results indicating which methods can be utilized for selection and prediction for the future. Neither objective methods of assessment nor individual clinical judgments were highly effective in predicting the criteria, although some individual clinicians made predictions that were significantly better than chance. Holt & Luborsky's book includes a detailed set of recommendations for further studies, which may be useful. However, as the authors are aware, in all such studies the handling of criterion problems will have to be considerably improved before any set of predictors can be demonstrated to be useful.

Patient variables.—The problem of patients who leave therapy early still presents an active area of research. Rosenthal & Frank (87) studied the out-patient population of a large psychiatric clinic. Approximately one out of every three patients referred for psychotherapy failed to accept it when it became available, although they previously had agreed to try it. Those of lower social class were less likely to accept. Three out of every four patients who began psychotherapy terminated without discussing this step with their therapists. In general, the authors are discouraged with the use of insight-based psychotherapies with this population, and feel that wider experimentation with other kinds of psychotherapy is called for. Although, in generalization, their findings must be limited to a population that, for the most part, did not come originally seeking psychotherapy, and the psychotherapists treating them were not of similar skill, training, and experience, still the results are quite startling and should shake some entrenched beliefs.

Lorr, Katz & Rubinstein (63) tested the hypotheses that early terminators are more likely to show impulsivity, are less dissatisfied, more likely to report anxiety, have more limited vocabularies, are more authoritarian, and are of lower social-economic level. *A priori* keys on a battery of tests failed to differentiate early terminators (less than 6 weeks) from remainers (26 weeks or more). An empirical key derived on one-half the sample correlated with the criteria in the second, cross-validation half of the sample .43. The generality of these findings and the theoretical significance of the empirical key are still in doubt. A second study (52) with the same subjects and variables showed that the predictors of length of stay did not correlate with ratings of improvement. The therapist's years of experience, the therapist's diagnostic classification of the patient, and the presence or absence of personal analysis of the therapist were variables also studied. The first two correlated with the ratings of improvement, but not with length of stay in therapy. It is somewhat surprising that these studies did not include tests specifically designed

to measure dependency, which has been clinically related to length of stay in therapy by therapists of almost any persuasion.

Hiler (43) investigated the relationship between continuation in psychotherapy and Wechsler-Bellevue scores in a population of 133 Veterans Administration Mental Hygiene Clinic patients. The patients who remained in psychotherapy scored significantly higher in over-all IQ. The difference between remainers and terminators was greater for the verbal than for the performance subscales.

A second study by Hiler (42) provides some methodological advance in this area of research. Hiler attempted, not merely to study the characteristics of patients terminating early or therapists whose patients terminated early, but also the interaction of the two variables, that is, what kinds of patients terminated early with what kinds of therapists. Since earlier studies had indicated that productivity on the Rorschach was related to early termination, Hiler asked the question of what kinds of therapists tended to hold on longer to the less-productive patients as defined by Rorschach productivity scores. The patients and therapists in this study were obtained at a Veterans Administration Mental Hygiene Clinic. The findings indicate that female therapists hold on to nonproductive patients better than male therapists, and that the patients of therapists rated as warm, according to the judgments of three psychologists, were also less likely to drop out if they were nonproductive by the criteria of number of Rorschach responses. Therapists rated as more competent tended to lose a smaller proportion of the more productive patients. Professional training of the therapist was not a significant variable. It is not clear in this study whether the possibility of selection of the kinds of patients referred to the different kinds of therapists was eliminated. If this does not constitute a contaminating variable, the findings are of both practical and theoretical significance. Perhaps more important is that the study demonstrates the fruitfulness of an interaction type of design, so that ultimately the question will not be posed as to what kind of therapist is the good one or what kind of therapy is the best one, but rather what kind of therapists are likely to have the best results with what kind of patients?

Kirtner & Cartwright (54) investigated success and failure in client-centered therapy as a function of initial interview behavior. Successes and failures were broken down into five groups: short and long failures, short and long successes, and an intermediate group of failure cases ranging between 13 and 21 interviews. Patient personality was categorized into five descriptions. Since there were five categories of outcome and five categories of personality characteristics, the forty-two cases were too small in number for definitive results. Analysis of the data by inspection, however, does strongly suggest that patient characteristics before therapy are highly related to the outcome of treatment in client-centered therapy. Apparently, the characteristic which leads to greatest success as judged within the framework of client-centered treatment is the tendency already present in the patient to focus internally

and his willingness to deal at a feeling level. At the other end of the continuum is the patient who deals with problems almost as though they were external to himself and focuses outside of himself in discussing his problem, avoiding discussion of internal feelings. The categorization of initial personality characteristics appears to have high interjudge reliability as demonstrated by two well-trained judges.

Kirtner & Cartwright (53) also studied the outcome of psychotherapy as a function of personality variables measured by Thematic Apperception Test analysis. The method of analysis involved six scales. Outcome was divided into five categories. With only 26 subjects, the large number of variables and categories could hardly be expected to achieve stable and clear-cut results. The authors feel the study indicates that therapy length-by-outcome is related to the personality structure of clients at the beginning of therapy.

Greenfield (37) obtained Minnesota Multiphasic Personality Inventories from patients entering therapy and was able to compare these with scores on the same test taken routinely when students were entering college. Thirty-one students involved had taken the test an average of 11 months before beginning treatment. Since he found no significant differences for the two administrations, Greenfield feels that the results challenge the generally accepted hypothesis that people seeking psychotherapy are most disturbed at the time of applying for treatment, although he recognizes that an alternate interpretation involves the validity of the MMPI for this purpose.

Another study dealing with the characteristics of clients seeking personal counseling is reported by Terwilliger & Fiedler (107). They report that the seeking of personal counseling is related to anxiety and feelings of lack of self-satisfaction and self-esteem rather than reality factors. By reality factors they mean external conditions of frustration, such as poor grades, low esteem of others, etc.

Luria (64) utilized Osgood's semantic differential approach to study the differences between patients and controls. Therapy patients indicated less favorable self-concepts, less favorable views of their parents, and more differences between their attitudes toward the two parents. The effect of therapy was primarily to change the self-concept but not the concept of others. The therapists and methods of treatment in the study were heterogeneous. The generality of the results regarding the effects of treatment is consequently unknown.

Process variables.—Process studies in psychotherapy deal with the interaction of therapist and patient or with the patient's behavior in psychotherapy as a function of some more or less controlled stimulation. Such investigations have become increasingly popular in an attempt to break down what happens during psychotherapy for the purpose of obtaining a better understanding of behavior change as a result of treatment and also as a technique of studying personality in a semicontrolled life situation.

In addition to other stimulating papers referred to elsewhere in this

chapter, the 1958 Conference on Research in Psychotherapy (89) produced several significant contributions to research in this area. Two of these deal primarily with methods of coding or describing specific patient-therapist interactions. Leary & Gill (60) have extended and elaborated the system of description of personality earlier given in Leary's *Interpersonal Diagnosis of Personality* (59) to the problem of coding therapy interactions. Their system is elaborate and complex, involving the classification of therapist's purposes and behaviors and patient's reactions at the overt verbal level, nonverbal level, and unconscious level, as well as categories for classifying needs and other formal characteristics of the content of the patient's reactions. Thus far there have been some tests of the reliability of coding, but not of the utility of the method. Apparently the authors are operating with a psychoanalytic-eclectic orientation with such a large number of variables that they hope that the more crucial variables will not be missed. A single patient statement may include 30 or 40 codifiable units. Whether or not the significant factors of interpersonal interaction or psychotherapy can be constructed out of these bits and pieces will only be determined by extensive research.

Saslow & Matarazzo (96) review their research with the "interaction chronograph." Their technique is to make a formal analysis of the subject's responses to an interview in which the interviewer's behavior is highly controlled. The duration and frequency of interviewer utterances and silences, as well as the direction (agreeing, disagreeing) are standardized in this method. The object is to make the interviewer "an instrument of research of considerable reliability." They deal with such formal characteristics of the patient's responses as the number of times the patient reacted, duration of the patient's reactions, duration of his silences, his tempo, frequency of interruptions, etc., and are able to demonstrate that two highly-trained interviewers can produce the same behavior in patients. The reliabilities on their measures approach those of objective personality tests. The two observers have had intensive training and the reliability of the method with less-trained interviewers is not known. In a separate study, Matarazzo, Saslow & Hare (68) describe a factor analysis of 12 measures of the interaction chronograph. Matarazzo *et al.* (67) report on psychological test and organismic correlates of the interview-interaction patterns. A number of meaningful correlations were established with a sample of 20 patients and cross-validated on a second sample.

Thus far the interaction chronograph has not been used as a method of therapy or for studying the typical variables presumably important in the psychotherapeutic process, but its potentiality for introducing more control into such studies is evident. The very demonstration that the interviewer's behavior can be highly standardized with regard to the variables the authors have studied at least holds out high promise that these same variables, or others, can also be controlled in studies of patient-therapist interaction.

In reviewing the program of research at the University of Michigan, Bordin (11) places great reliance on the patient-therapist interaction stress-

ing that the best method of studying patient and therapist characteristics lies in its study. Investigators in this program of research have been concerned with such variables as depth of interpretation, blocking, self-concern, opposition, explanation, etc. One interesting variation in methodology involving an attempt to measure the emotional reactions of the therapist is described. In order to avoid the interference of galvanic skin response (GSR) apparatus in actual psychotherapy, the GSR reactions of the therapist are recorded while he listens to a tape of his own treatment interview. Bordin also describes some beginning attempts to move out of the psychotherapy situation and into the laboratory to test hypotheses such as the prediction of problem-solving behavior. Bordin emphasizes the use of the psychotherapy interaction for the study of personality theory, but whether or not his therapeutic situations offer sufficient control to isolate significant variables is an unresolved issue.

One example of the program of research reported by Bordin was published by Cutler *et al.* (17). They studied ratings of "depth of interpretation" on typescripts and tapes and found that experts (two trained psychoanalysts) do not make better use of context or show higher reliability than do less experienced judges. In general, reliabilities for such judgments were low—in the .30 to .40 range for nonpsychotic cases and in the .10 to .30 range for psychotic cases.

A review of the work at Pennsylvania State University is provided by Snyder (103). Snyder summarizes the program of research, including investigations of patient characteristics, the therapy relationship, therapist's characteristics, and the techniques of therapy. He describes a number of variables used to measure differences among patients, among therapists, and for the measurement of change within therapy and therapeutic interaction. Much of the research he has reported involves the use of students in training as therapists in which the students are sometimes instructed to use particular methods which they may or may not fully grasp or accept. This practice has led to some questions about generalizing the results of these studies. It is true that several studies have failed to show significant superiority of experts over beginning therapists. However, the dimension of experience may vary from beginning training to 30 or more years of doing the same thing over and over. The relationship of experience to variables such as skill, judgment, homogeneity of attitude, etc. may not be linear and may not be the same for one method of treatment as it is for another.

An excellent and comprehensive review of psychophysiological approaches to the measurement of psychological reaction has been contributed by Lacey (58). Although only a small portion of the studies which he reviews have been conducted with patients in therapy, the material included is highly relevant to the question of the applicability and value of psychophysiological measures in research on psychotherapeutic process and outcome. The review itself is too comprehensive to be summarized, as is the general theory of autonomic functioning presented. One general conclusion of interest, however, is that

one measure of somatic arousal cannot serve as an index to the state of other measures and, consequently, single measures of subject or patient arousal or disturbance for different stimuli cannot be used unequivocally to rank-order individuals. Subjects tend to show a unique but reliable pattern of response to emotional stimuli. Of specific interest to studies of psychotherapy process is the presentation of data in support of the hypothesis that increase in cardiac rate is related to inhibitory action while increase in skin conductance is related to excitatory action.

Sternberg, Chapman & Shakow (104) investigated the effect of intrusions on privacy of psychotherapy research. Their problem was to determine the nature and extent of disturbance in the psychotherapeutic process by the intrusion of taking sound motion pictures. Opinions of six patients who had specific interviews sound-photographed and of their therapists were obtained. Another group of therapists and of subjects who were "potential" patients were interviewed regarding their feelings. The authors also studied college students', professional workers', and other adults' reactions to the intrusion on privacy by use of a series of cartoons. The authors are aware that their results are not definitive and that a great deal of additional research is necessary. They conclude, however, that the analysis of all the data supports the proposition that patients and therapists tend to adapt with time to the objective recording devices.

Eldred & Price (22) describe a semicontrolled method of analysis of patient speech to obtain judgments of feeling-states without relying on the content of speech. Judges noted alterations in pitch, volume, and rate, and the amount of breakup in speech in passages in which there was agreement about the communication of angry feelings, depressed feelings, and feelings of anxiety. They analyzed selected interviews from four cases in this way. The investigation is more illustrative than experimental. The authors feel that the method will allow for a more precise analysis of the role of vocalizations in the therapeutic process. They also feel that specific patterns can be used as objective criteria of clinical change. Although it is clear that such a method of determining the amount or kind of "emotional communication" may have considerable value in the study of psychotherapy, these authors have failed to deal with the annoying problem of the biasing effects of content on judges presumably rating other speech variables.

Rawn (83) had five experts make judgments by cue-sorting the statements of resistance and transference of one case seen in four sessions. He concluded that resistance and transference statements were independent of each other. Reliability of the judges was determined negatively, that is, no significant differences were found between the means of raters.

Auld & White (3) using two expert and two apprentice therapists, each with one patient, set up hypotheses to study sequential effects in therapy by analysis of patient-therapist units. However, their interscorer reliability was low, and bias in scoring was not controlled. They found some support for generalizations that silence is equivalent to resistant speech, that analytic

therapists have a higher probability of intervening after resistance, and that, contrary to client-centered theory, intervention reduces rather than increases resistance. The number of cases and therapists, however, was so small that these findings cannot be taken as anything more than interesting hypotheses for further investigation.

A study by Lebo (61) contributes to the neglected area of child therapy. Lebo had different toys ranked on the degree to which they stimulated verbalization and judged as to the categories of content of the verbalization they elicited. The content categories were also ranked on the basis of significance for therapeutic purposes. He feels that, by combining the two criteria, an index of value can be obtained.

Outcome research and criteria of improvement.—The difficulties in arriving at generalizations in psychotherapy research have already been enumerated and commented upon. The kind of generalization which seems the most difficult to make is that which applies to the efficiency, value, or relative superiority of any specific method of treatment. Rubinstein & Parloff (89, p. 277), in their summary of the American Psychological Association-sponsored conference on psychotherapy, had the following to say on the subject of outcome research:

Although one of the prime purposes of the conference, as described in the original plan, was to provide "a comprehensive picture of the status of research on the effects of psychotherapy," as if by some tacit agreement the issue of outcome was skirted by the conference.

General discussions of the problems inherent in such research are provided by Frank (30), Hunt *et al.* (48), and Ford (28).

In spite of the obvious difficulties, some of the researches attempting to evaluate the effects of psychotherapy have been completed and others are in progress. Robbins & Wallerstein (84) have described in detail a major research project of the Menninger Foundation to evaluate psychoanalytic therapy. Their basic technique will involve qualitative judgments of data relating to patient, method, and therapist, utilizing crude quantification of variables and correlational techniques. The method will be essentially naturalistic rather than controlled. Much of the data will be twice removed from the psychotherapy situation (i.e., supervisors' judgments concerning the therapists' account of what happened during the therapeutic hour). The authors are, however, under no illusions regarding the nature of this research and see it as at the level, described by Sargent (95), of finding and sharpening hypotheses within the framework of psychoanalytic theory and practice.

A similar comprehensive study of the effects of research has been described by Hunt *et al.* (48). A large-scale research, it has already involved 197 clients referred to the research project. Analyses are intended to relate patient's characteristics, therapist's characteristics, method, and interaction to improvement measures. Although some judgments will be used, there is obviously a much greater reliance on objective tests or instruments for which

bias is controlled. Thus far, only preliminary analysis of results has been completed.

Frank (30) describes a comparison of individual, group, and what is referred to as minimal therapy. His method involved three psychiatric residents, each treating six patients under each of the three conditions. Improvement was judged by tests and a conference of raters. Although he found that the patients receiving the group and individual therapy did better than those receiving minimal therapy, Frank recognizes the weakness of his criteria. He is also aware that none of the three therapists liked minimal therapy and all felt they were shortchanging the patients. It is, of course, equally likely that the therapist's attitude, and not the method, was responsible for any real differences that may have appeared.

The paper by Ford (28) reviews some of the general problems of research in the context of the Pennsylvania State University research program on psychotherapy. One study in progress, he reports, is worthy of special note because of its methodological implications. In this study, one therapist will be seeing 20 different clients. The clients will be tested at frequent intervals. The assumption is that differences in outcome can be related to the patient variables, since the therapist and method variables will be controlled. The research reported in this review strongly suggests that the assumption of standardized behavior on the part of the therapist is a shaky one. Although the findings will be of value in differentiating the kinds of clients responding to that particular therapist, generalization must be guarded. The kinds of cases that the particular therapist may like and may do best with may be considerably different from those that other therapists, presumably utilizing the same method, may like and do well with. Even the assumption that the method can be held constant for strikingly different patients does not seem wholly tenable in light of present evidence.

Dorfman (19) studied the outcome of individual child therapy. Only one therapist was used and, the author states, adequate controls were lacking. The subjects showed more improvement than normal controls for a similar time period on the Rogers Personality Adjustment Test and a sentence completion test constructed by the author. The improvement that did appear held up, but did not increase in a post-therapy test.

Graham (36) evaluated the effects of therapy by having patients judge improvement themselves on a five-point scale. Ninety-six adults made such evaluations in individual therapy and the parents of 44 children made evaluations of their children's improvement. As might be expected, patients who dropped out of therapy early report less improvement than those who stayed. Neurotics and the parents of the tested children report higher percentages of improvement with increased interviews. The psychotics did not report greater improvement with increased duration of therapy. Interestingly enough, patients seen twice a week reported significantly less improvement than those seen once a week. Whether the latter finding resulted from the

number of interviews or was a function of selective factors, based on which patients were seen once and which twice a week, is not clear.

A few investigators in this area are concerned with the adequacy of test measures of improvement in psychotherapy. Nebergall, Angelino & Young (75) found no relationship between sociometric pooled rankings of fraternity and sorority members and either self-rankings or discrepancy between self- and ideal-rankings. Turner & Vanderlippe (110) also studied self-ideal congruence as an index of adjustment. They obtained no relationship with health indices, but did find that highs and lows discriminated in sociometric measures.

Daley (18) studied the construct validity of the Chicago cue sort measures by relating them to frustration tolerance. Frustration tolerance was measured by the effect of criticism during an unsolvable task on a subsequent task. No significant relationship was obtained. A suggestion for a different kind of measure of improvement is provided by Mahrer (66). Mahrer describes the use of the concept of potential IQ as a measure of intellectual efficiency. Potential IQ is the score which would be obtained if alternative answers to intelligence test items were recorded and the subject was credited with his best, rather than his first, response. Reduction in the discrepancy between actual and potential IQ was suggested as a possible measure for improvement in psychotherapy. Although it is doubtful that this measure would have widespread applicability, particularly to so-called neurotic adults, it might be a useful method with subnormal or under-achieving children.

Experimental analogues.—One other approach to psychotherapy is beginning to gain a little headway. While some people are using psychotherapy situations to study general theory, there are others who are using controlled laboratory situations as psychotherapy analogues. The best known of these are the studies on verbal conditioning which have recently been reviewed by Krasner (56). It seems clear from Krasner's review of 31 studies in this area that subjects may be trained by reinforcement to emit a particular kind of response without being "aware" that they have been "conditioned." The reinforcements may be either verbal or nonverbal ("That's good," or a nod). Two different examiners may also produce significant differences in the rate of conditioning. Although this research was not carried out in actual psychotherapeutic situations, the author feels that these studies throw doubt on the use of content in psychotherapy to support theory. They also raise questions about the use of internal verbal criteria for improvement, either patient or therapist judgments, self-description statements, or analysis of interview content.

Buss & Durkee (15) investigated the conditioning of hostile vs. neutral verbalizations in a situation resembling a clinical interview. They found that hostile words conditioned faster than neutral, which they felt was due to the fact that hostile words made up a unique and easier classification. Salzinger & Pisoni (93) successfully attempted to reinforce self-referral affect state-

ments of schizophrenic patients during an interview. By using a standard procedure, they obtained the same results with different interviewers. Sarason (94) examined individual differences in verbal conditioning, concluding that verbal conditioning was slower for noncompliant subjects.

A study employing the Skinnerian approach was reported by Flanagan, Goldiamond & Azrin (27). Using only three stuttering subjects, the authors demonstrated some effects of following stuttering by aversive stimulation and by the cessation of continuous aversive stimulation.

James & Rotter (49) followed up on the work of Phares (80), which provided evidence that individuals vary in the extent to which they generally tend to perceive the locus of reinforcement as being internally or externally controlled. Although James & Rotter did not deal with individual differences, they demonstrated that verbal expectancies are differently affected if the subject believes that it is his own skill that is determining outcome on a task rather than chance or external forces. Since many patients in therapy apparently believe that external forces rather than their own behavior are determining their satisfactions, the authors raised the question of whether therapy would not have to deal with this general attitude before changes in behavior can take place in regard to more specific expectancies.

OVER-ALL TRENDS

1. With regard to the practice and underlying theory of psychotherapy, the trend towards greater flexibility in techniques is apparent. Awareness of the fact that different patients respond differentially to the same method of treatment is growing. On practical and, to some extent, on theoretical grounds, there is much more concern with attempting to suit the technique of psychotherapy to the particular patient. Along with this is a greater appreciation of the interaction between patient and therapist as being of primary importance in determining the outcome of therapy, and of the fact that some patient-therapist combinations may do better with one method than with another.

2. The current literature suggests that even the most conservative Freudian analysts are paying greater attention to what is referred to as ego psychology, feelings of inadequacy, inferiority, impossible life goals, sibling rivalry, and, particularly, the problem of dependency. More and more the patient is seen in the dependent role of the child rather than fixated at some highly specific early stage of sexual development, or caught in an unresolved Oedipus complex. The obvious Adlerian source of these ideas continues to be curiously unrecognized. In general, the emphasis on the sexual motive is waning.

3. Along with these changes in theory is a willingness to challenge old taboos and beliefs in regard to psychotherapy, both in clinical writing and research findings. Established beliefs emphasizing the importance of experience and personal analysis are being seriously challenged. Similarly, the passive, constrained, and nonjudgmental role of the therapist is being ques-

tioned. Particularly in the case of the treatment of psychotic patients is there a willingness to experiment with new methods, no doubt arising, in part, from a lack of success with conventional methods.

4. Research studies in psychotherapy tend to be concerned more with some aspects of the psychotherapeutic procedure and less with outcome. In part this is due to the discouragement with obtaining generalizable results from outcome studies, and, to some extent, it reflects an interest in the psychotherapy situation as a kind of personality laboratory. Current investigations emphasize characteristic attitudes and behavior of different kinds of patients and therapists, and the interaction between patients and therapists within a specific therapy hour. The words "cure" and "improvement" are being supplanted by "change" and "response."

Although the therapist has always been considered important in psychotherapy, he is being regarded with greater care in research as well as theory. His ability to communicate, the effects of his verbal and nonverbal responses, the effects of his personal analysis, experience, values, etc. are all being examined in relation to such dependent variables as attitude scales, patient's behavior, the therapist's skill in predicting the patient's behavior, and his own behavior in therapy.

5. The issue of values, never absent in psychotherapy, has become increasingly important. Articles dealing with values are of two kinds. One of these, which is outside of the realm of science, raises questions about the kind of values the psychotherapist should have or which should govern his behavior and the social consequences of the values implicit in different conceptions of the nature of psychotherapy. The other type of inquiry deals descriptively with the effects the therapist's various values have upon his behavior in the therapy situation.

COMMENTS

1. While the reviewer holds no brief for a mechanistic, oversimplified or "superficial" view of man, it seems apparent that the field of psychotherapy will be rife with confusion and wasted effort until some attempt is made to clear up or make more scientific the language typically used. Many terms are labels which connote more propaganda value or status value than they communicate information. Such terms as "psychoanalysis," "psychoanalytically oriented," "neo-analytic," "dynamic," "rational," etc. are used freely, and rarely are carefully defined. They are certainly not often used by different individuals to mean the same thing. Other terms describing either techniques of psychotherapy or goals of psychotherapy are even worse. "Freedom," "becoming," "integration," "spontaneity," "living process," "self realization," "flow" appear to communicate more feeling than they do meaning. Words such as "transference," "insight," "interpretation," "reflection of feeling," "warmth," "countertransference," etc. are sometimes more carefully defined, but they are likely to have a somewhat different definition by everyone who attempts carefully to describe his own referents for the term.

Part of the difficulty, as indicated by Fromm, is the ego involvement and value connotations attached to particular words. Although this is an old problem in psychology, the lag in the field of psychotherapy in recognizing and attempting to deal with it seems more marked than in some other areas of psychology.

2. Although the trend is gradually away from the notion of psychotherapy as an entity, there is still too much concern with "the process of therapy." For many there is an assumption that there is some special process which takes place in patients, accounting for their improvement or cure. The purpose of experimental or clinical analysis is to discover what this process really is. In a similar way, the role of the therapist is conceived of as some ideal set of behaviors which will maximally facilitate the mysterious process. The alternative conception that psychotherapy is basically a social interaction which follows the same laws and principles as other social interactions, and in which many different effects can be obtained by a variety of different conditions, is frequently neglected.

3. As in other problems in applied psychology, the criterion problem is the most difficult to tackle and the most frequently avoided. The field of psychotherapy would benefit considerably if more investigators would turn their attention to (a) carefully and systematically defining the variables in which change can take place and (b) developing relatively objective measures of change which have been carefully standardized and validated. Although the difficulty of developing operations in the personality-measurement field is indeed great, no progress can be obtained until such measures have been devised. The use of standard personality instruments developed for other purposes often will not serve the more specific purposes of measuring the changes that take place in, and as a result of, psychotherapy. The building of special instruments which are specifically suited for the kinds of changes which have some theoretical rationale and which take into account the nature of the potential subjects who will use them, the peculiar involvements of these subjects in their therapy experience, and the special conditions of testing is obviously going to be a difficult and arduous process. On the other hand, avoidance of the problem leads nowhere, and it is hardly wise to spend large amounts of time, effort, and money on experimental designs which, in the long run, are unsatisfactory because of inadequate measurement criteria.

4. Research in psychotherapy is becoming more and more sophisticated and productive. However, there is still at least a reasonable question as to whether such research is valuable for the answers it provides, either to the practical problems of psychotherapy or to the theory of personality. This reviewer tends to feel that there is a relative lack of appreciation of the potential for using laboratory analogues in which the principles underlying psychotherapy can be investigated under relatively controlled conditions. Such research in the long run may turn out to be more fruitful in the development of a scientific approach to psychotherapy than will research with actual psychotherapy situations. However, the study of psychotherapy in both con-

trolled and semicontrolled fashion may well continue to be the best source for the development of hypotheses about the nature of complex social learning and personality which will have to be tested under more controlled conditions.

LITERATURE CITED

1. Ackerman, N. W. Toward an integrative therapy of the family. *Am. J. Psychiat.*, **114**, 727-33 (1958)
2. Alexander, F. Unexplored areas in psychoanalytic theory and treatment. *Behavioral Sci.*, **3**, 293-316 (1958)
3. Auld, F., and White, A. M. Sequential dependencies in psychotherapy. *J. Abnormal Social Psychol.*, **58**, 100-4 (1959)
4. Barbara, D. A. Communication in psychotherapy. *Am. J. Psychother.*, **12**, 253-63 (1958)
5. Barber, T. Z. The concept of hypnosis. *J. Psychol.*, **45**, 115-31 (1958)
6. Battegay, R. Group therapy with alcoholics and analgesic addicts. *Intern. J. Group Psychother.*, **8**, 428-34 (1958)
7. Beard, J. H., Goertzel, V., and Pearce, A. J. The effectiveness of activity group therapy with chronically regressed adult schizophrenics. *Intern. J. Group Psychother.*, **8**, 123-34 (1958)
8. Bergman, P. The role of faith in psychotherapy. *Bull. Menninger Clin.*, **22**, 92-103 (1958)
9. Blaine, G. B., and McArthur, C. C. What happened in therapy as seen by the patient and his psychiatrist? *J. Nervous Mental Disease*, **127**, 344-50 (1958)
10. Boileau, V. K. New techniques in brief psychotherapy. *Psychol. Repts.*, **4**, 627-45 (1958)
11. Bordin, E. S. Inside the therapeutic hour. *Research in Psychotherapy*, 235-46 (American Psychological Association, Inc., Washington, D. C., 293 pp., 1959)
12. Bowers, M. K., Berkowitz, B., and Brecher, S. Therapeutic implications of analytical group psychotherapy of religious personnel. *Intern. J. Group Psychother.*, **8**, 243-56 (1958)
13. Bowers, M. K., Mullan, H., and Berkowitz, B. Observations on suicide occurring during group psychotherapy. *Am. J. Psychother.*, **13**, 93-106 (1959)
14. Brody, E. B. What do schizophrenics learn during psychotherapy and how do they learn it? *J. Nervous Mental Diseases*, **127**, 66-76 (1958)
15. Buss, A. H., and Durkee, A. Conditioning of hostile verbalizations in a situation resembling a clinical interview. *J. Consulting Psychol.*, **22**, 414-18 (1958)
16. Cutler, R. L. Countertransference effects in psychotherapy. *J. Consulting Psychol.*, **22**, 349-56 (1958)
17. Cutler, R. L., Bordin, E. S., Williams, J., and Rigler, D. Psychoanalysts as expert observers of the therapy process. *J. Consulting Psychol.*, **22**, 335-40 (1958)
18. Daley, S. J. Construct validity of the Chicago Q-Sort: frustration, tolerance. *J. Clin. Psychol.*, **15**, 177-79 (1958)
19. Dorfman, E. Personality outcomes of client-centered child therapy. *Psychol. Monographs*, **72**(3), 22 pp. (1958)
20. Ekstein, R. Faith and reason in psychotherapy. *Bull. Menninger Clin.*, **22**, 104-8 (1958)

21. Ekstein, R., and Wallerstein, R. S. *The Teaching and Learning of Psychotherapy* (Basic Books, Inc., New York, N. Y., 334 pp., 1958)
22. Eldred, S. H., and Price, D. B. The linguistic evaluation of feeling states in psychotherapy. *Psychiatry*, **21**, 115-21 (1958)
23. Ellis, A. Hypnotherapy with borderline schizophrenics. *J. Gen. Psychol.*, **59**, 245-53 (1958)
24. Ellis, A. Rational psychotherapy. *J. Gen. Psychol.*, **59**, 35-49 (1958)
25. Fey, W. F. Doctrine and experience: their influence upon the psychotherapist. *J. Consulting Psychol.*, **22**, 403-9 (1958)
26. Filmer-Bennett, G., and Hillson, J. S. Some child therapy practices. *J. Clin. Psychol.*, **15**, 105-6 (1959)
27. Flanagan, B., Goldiamond, I., and Azrin, N. Operant stuttering: the control of stuttering behavior through response-contingent consequences. *J. Exptl. Analysis Behavior*, **1**, 173-77 (1958)
28. Ford, D. H. Research approaches to psychotherapy. *J. Counseling Psychol.*, **6**, 55-60 (1959)
29. Frank, G. H. On neurosis: theory and treatment. *Psychol. Repts.*, **4**, 723-28 (1958)
30. Frank, J. D. Problems of control in psychotherapy as exemplified by the psychotherapy research project of the Phipps Psychiatric Clinic. *Research in Psychotherapy*, 10-26 (American Psychological Association, Inc., Washington, D. C., 293 pp., 1959)
31. Fromm, E. *Sigmund Freud's Mission* (Harper & Brothers, New York, N. Y., 120 pp., 1959)
32. Fromm-Reichman, F. Basic problems in the psychotherapy of schizophrenia. *Psychiatry*, **21**, 1-6 (1958)
33. Ganzarain, R., Davanzo, H., and Cizaletti, J. Group psychotherapy in the psychiatric training of medical students. *Intern. J. Group Psychother.*, **8**, 137-53 (1958)
34. Ginott, H. G. Play group therapy: a theoretical framework. *Intern. J. Group Psychother.*, **8**, 410-18 (1958)
35. Glad, D. D. *Operational Values in Psychotherapy* (Oxford University Press, New York, N. Y., 326 pp., 1959)
36. Graham, S. R. Patient evaluation of the effectiveness of limited psychoanalytically oriented psychotherapy. *Psychol. Repts.*, **4**, 231-34 (1958)
37. Greenfield, N. S. Personality pattern of patients before and after application for therapy. *J. Consulting Psychol.*, **22**, 280 (1958)
38. Greenhill, M. H. The focal communication concept. *Am. J. Psychother.*, **12**, 30-41 (1958)
39. Gruenthal, M. Aims and limitations of psychotherapy with schizophrenics and borderline cases in private practice. *Am. J. Psychother.*, **12**, 465-72 (1958)
40. Hadden, S. B. Treatment of homosexuality by individual and group psychotherapy. *Am. J. Psychiat.*, **114**, 810-15 (1958)
41. Heath, R. G., Leach, B. E., Byers, L. W., Martens, S., and Feigley, C. A. Pharmacological and biological psychotherapy. *Am. J. Psychiat.*, **114**, 683-89 (1958)
42. Hiler, E. W. An analysis of potential therapist compatibility. *J. Consulting Psychol.*, **22**, 341-47 (1958)
43. Hiler, E. W. Wechsler-Bellevue as a predictor of continuation in psychotherapy. *J. Clin. Psychol.*, **14**, 192-94 (1958)

44. Hill, L. B. On being rather than doing in psychotherapy. *Intern. J. Group Psychother.*, **8**, 115-22 (1958)
45. Holt, R. R., and Luborsky, L. *Personality Patterns of Psychiatrists* (Basic Books, Inc., New York, N. Y., 386 pp., 1958)
46. Hora, T. Existential group psychotherapy. *Am. J. Psychother.*, **13**, 83-92 (1959)
47. Hora, T. Group psychotherapy, human values and mental health. *Intern. J. Group Psychother.*, **8**, 154-60 (1958)
48. Hunt, J. McV., Ewing, T. N., LaForge, R., and Gilbert, W. M. An integrated approach to research on therapeutic counseling, with samples of results. *J. Counseling Psychol.*, **6**, 46-54 (1959)
49. James, W. H., and Rotter, J. B. Partial and 100% reinforcement under chance and skill conditions. *J. Exptl. Psychol.*, **55**, 397-403 (1958)
50. Jones, H. A contribution to the evaluation of some methods of residential therapy. *Human Relations*, **11**, 52-65 (1958)
51. Kaldeck, R. Group psychotherapy with mentally defective adolescents and adults. *Intern. J. Group Psychother.*, **8**, 185-92 (1958)
52. Katz, M. M., Lorr, M., and Rubinstein, E. A. Remainer patient attributes and their relation to subsequent improvement in psychotherapy. *J. Consulting Psychol.*, **22**, 411-13 (1958)
53. Kirtner, W. L., and Cartwright, D. S. Success and failure in client-centered therapy as a function of client personality variables. *J. Consulting Psychol.*, **22**, 259-64 (1958)
54. Kirtner, W. L., and Cartwright, D. S. Success and failure in client-centered therapy as a function of initial in-therapy behavior. *J. Consulting Psychol.*, **22**, 329-33 (1958)
55. Kotkov, B. Favorable clinical indications for group attendance. *Intern. J. Group Psychother.*, **8**, 419-27 (1958)
56. Krasner, L. Studies of the conditioning of verbal behavior. *Psychol. Bull.*, **55**, 148-70 (1958)
57. Kräupl-Taylor, F. A history of group and administrative therapy in Great Britain. *Brit. J. Med. Psychol.*, **31**, 153-73 (1958)
58. Lacey, J. I. Psychophysiological approaches to the evaluation of psychotherapeutic process and outcome. *Research in Psychotherapy*, 160-208 (American Psychological Association, Inc., Washington, D. C., 293 pp., 1959)
59. Leary, T. *Interpersonal Diagnosis of Personality* (The Ronald Press Company, New York, N. Y., 518 pp., 1957)
60. Leary, T., and Gill, M. The dimensions and a measure of the process of psychotherapy: a system for the analysis of content of clinical evaluations and patient-therapist verbalizations. *Research in Psychotherapy*, 62-95 (American Psychological Association, Inc., Washington, D. C., 293 pp., 1959)
61. Lebo, D. A formula for selecting toys for nondirective play therapy. *J. Genet. Psychol.*, **92**, 23-34 (1958)
62. Lebo, D. A theoretical framework for nondirective play therapy: concepts from psychoanalysis and learning theory. *J. Consulting Psychol.*, **22**, 275-79 (1958)
63. Lorr, M., Katz, M. M., and Rubinstein, E. A. The prediction of length of stay in psychotherapy. *J. Consulting Psychol.*, **22**, 321-27 (1958)
64. Luria, Z. A semantic analysis of a normal and a neurotic therapy group. *J. Abnormal Social Psychol.*, **58**, 216-20 (1959)
65. MacDonald, D. E. Group psychotherapy with the wives of alcoholics. *Quart. J. Studies Alc.*, **19**, 125-31 (1958)

66. Mahrer, A. R. Potential intelligence: a learning theory approach to description and clinical implications. *J. Gen. Psychol.*, **59**, 59-71 (1958)
67. Matarazzo, R. G., Matarazzo, J. D., Saslow, G., and Phillips, J. S. Psychological test and organismic correlates of interview interaction patterns. *J. Abnormal Social Psychol.*, **56**, 329-38 (1958)
68. Matarazzo, J. D., Saslow, G., and Hare, A. P. Factor analysis of interview interaction behavior. *J. Consulting Psychol.*, **22**, 419-29 (1958)
69. May, R., Angel, E., and Ellenberger, H. F. (Eds.). *Existence* (Basic Books, Inc., New York, N. Y., 445 pp., 1958)
70. McKinnon, K. M. A clinical evaluation of the method of direct analysis in the treatment of psychosis. *J. Clin. Psychol.*, **15**, 80-96 (1959)
71. Menninger, K. *Theory of Psychoanalytic Technique* (Basic Books, Inc., New York, N. Y., 206 pp., 1958)
72. Miller, D. H. Family interaction in the therapy of the adolescent patient. *Psychiatry*, **21**, 277-84 (1958)
73. Morse, P. W. Psychotherapy with nonreflective and aggressive patients. *Am. J. Orthopsychiat.*, **28**, 352-60 (1958)
74. Murphy, W. F. A comparison of psychoanalysis with dynamic psychotherapies. *J. Nervous Mental Disease*, **126**, 441-50 (1958)
75. Nebergall, N. S., Angelino, H. L., and Young, H. H. A validation study of the self-activity inventory as a predictor of adjustment. *J. Consulting Psychol.*, **23**, 21-29 (1959)
76. Orgel, S. Z. Effect of psychoanalysis on the course of peptic ulcer. *Psychosomat. Med.*, **20**, 117-23 (1958)
77. Papanek, H. Change in ethical values in group psychotherapy. *Intern. J. Group Psychother.*, **8**, 435-44 (1958)
78. Papanek, H. Ethical values in psychotherapy. *J. Individual Psychol.*, **14**, 160-66 (1958)
79. Patterson, C. H. The place of values in counseling and psychotherapy. *J. Counseling Psychol.*, **5**, 216-223 (1958)
80. Phares, E. J. Expectancy changes in skill and chance situations. *J. Abnormal Social Psychol.*, **54**, 339-42 (1957)
81. Phillipson, H. The assessment of progress after at least two years of group psychotherapy. *Brit. J. Med. Psychol.*, **31**, 32-41 (1958)
82. Pine, I., Gardner, M., and Tippet, D. L. Experiences with short-term group psychotherapy. *Intern. J. Group Psychother.*, **8**, 276-84 (1958)
83. Rawn, M. L. An experimental study of transference and resistance phenomena in psychoanalytically oriented psychotherapy. *J. Clin. Psychol.*, **14**, 418-25 (1958)
84. Robbins, L. L., and Wallerstein, R. S. The research strategy and tactics of the psychotherapy research project of the Menninger Foundation and the problem of controls. *Research in Psychotherapy*, 27-43 (American Psychological Association, Inc., Washington, D. C., 293 pp., 1959)
85. Rogers, C. R. A process conception of psychotherapy. *Am. Psychologist*, **13**, 142-49 (1958)
86. Rogers, C. R. A tentative scale for the measurement of process in psychotherapy. *Research in Psychotherapy*, 96-107 (American Psychological Association, Inc., Washington, D. C., 293 pp., 1959)

87. Rosenthal, D., and Frank, J. D. The fate of the psychiatric clinical outpatients assigned to psychotherapy. *J. Nervous Mental Disease*, **127**, 330-43 (1958)
88. Rosenthal, H. R. Psychotherapy for the aging. *Am. J. Psychother.*, **13**, 55-65 (1959)
89. Rubinstein, E. A., and Parloff, M. B. Research problems in psychotherapy. *Research in Psychotherapy*, 276-93 (American Psychological Association, Inc., Washington, D. C., 293 pp., 1959)
90. Rubinstein, L. H. Psychotherapeutic aspects of male homosexuality. *Brit. J. Med. Psychol.*, **30**, 14-18 (1958)
91. Sager, C. J. Freedom and psychotherapy. *Am. J. Psychother.*, **13**, 4-17 (1959)
92. Sakel, M. J. The importance of the Adlerian orientation in psychotherapy. *J. Individual Psychol.*, **14**, 158-59 (1958)
93. Salzinger, K., and Pisoni, S. Reinforcement of affect responses of schizophrenics during the clinical interview. *J. Abnormal Social Psychol.*, **57**, 84-90 (1958)
94. Sarason, I. G. Interrelationships among individual difference variables, behavior in psychotherapy and verbal conditioning. *J. Abnormal Social Psychol.*, **56**, 339-44 (1958)
95. Sargent, H. D. The psychotherapy research project of the Menninger Foundation. II. Rationale. *Bull. Menninger Clin.*, **20**, 226-33 (1956)
96. Saslow, G., and Matarazzo, J. D. A technique for studying changes in interview behavior. *Research in Psychotherapy*, 125-59 (American Psychological Association, Inc., Washington, D. C., 293 pp., 1959)
97. Saul, L. J. *Technique and Practice of Psychotherapy* (J. B. Lippincott Co., Philadelphia, Pa., 244 pp., 1958)
98. Schneer, H. I., and Hewlett, I. W. A family approach to stuttering with group therapy techniques. *Intern. J. Group Psychother.*, **8**, 329-41 (1958)
99. Searles, H. F. The schizophrenic's vulnerability to the therapist's unconscious processes. *J. Nervous Mental Disease*, **127**, 247-62 (1958)
100. Shellow, R. S., Ward, J. L., and Rubinfeld, S. Group therapy and the institutionalized delinquent. *Intern. J. Group Psychother.*, **8**, 265-75 (1958)
101. Sherman, M. H. Psychotherapy with adolescent girls in a court clinic. *J. Genet. Psychol.*, **92**, 3-9 (1958)
102. Slavson, S. R. A bio-quantum theory of the ego and its application to analytic group psychotherapy. *Intern. J. Group Psychother.*, **9**, 3-30 (1959)
103. Snyder, W. U. Some investigations of relationship in psychotherapy. *Research in Psychotherapy*, 247-59 (American Psychological Association, Inc., Washington, D. C., 293 pp., 1959)
104. Sternberg, R. S., Chapman, J. C., and Shakow, D. Psychotherapy research and the problem of intrusions on privacy. *Psychiatry*, **21**, 195-203 (1958)
105. Strupp, H. H. The performance of psychiatrists and psychologists in a therapeutic interview. *J. Clin. Psychol.*, **14**, 219-26 (1958)
106. Strupp, H. H. The performance of psychoanalytic and client-centered therapists in an initial interview. *J. Consulting Psychol.*, **22**, 265-74 (1958)
107. Terwilliger, J. S., and Fiedler, F. E. An investigation of determinants inducing individuals to seek personal counseling. *J. Consulting Psychol.*, **22**, 288 (1958)
108. Thompson, C. Various methods of psychotherapy and their functions. *Am. J. Psychother.*, **12**, 660-70 (1958)

109. Thorne, F. C. Structuring eclectic psychotherapy for the client. *J. Clin. Psychol.*, **15**, 96-104 (1959)
110. Turner, R. H., and Vanderlippe, R. H. Self-ideal congruence as an index of adjustment. *J. Abnormal Social Psychol.*, **57**, 202-6 (1958)
111. *What, Then, Is Man?* (Concordia Publishing House, St. Louis, Mo., 351 pp., 1958)
112. Walters, O. S. Metaphysics, religion and psychotherapy. *J. Counseling Psychol.*, **5**, 243-52 (1958)
113. Watson, G. Moral issues in psychotherapy. *Am. Psychologist*, **13**, 574-76 (1958)
114. Weigert, E. Problems of communication between doctor and patient in psychotherapy. *Psychiatry*, **21**, 241-48 (1958)
115. White, J. G. The use of learning theory and the psychological treatment of children. *J. Clin. Psychol.*, **15**, 227-29 (1959)
116. Whitehorn, J. C. Goals of psychotherapy. *Research in Psychotherapy*, 1-9 (American Psychological Association, Inc., Washington, D. C., 293 pp., 1959)
117. Will, O. A. Psychotherapeutics and schizophrenic reactions. *J. Nervous Mental Disease*, **126**, 109-40 (1958)
118. Winder, A. E., and Hersko, M. A thematic analysis of an outpatient psychotherapy group. *Intern. J. Group Psychother.*, **8**, 293-300 (1958)
119. Wolf, A., and Schwartz, E. K. Irrational psychotherapy: an appeal to unreason. *Am. J. Psychother.*, **12**, 300-14 (1958)
120. Wolpe, J. *Psychotherapy by Reciprocal Inhibition* (Stanford University Press, Stanford, Calif., 239 pp., 1958)

PSYCHOPHARMACOLOGY^{1,2}

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The task of reviewing the development of psychopharmacology is a formidable one, which only dedicated, highly involved, or foolhardy individuals undertake. The problem arises from the thousands of reports which have appeared in the past five years or so on the effects of drugs as related to some aspect of behavior. Not only are there many reports, but the number of drugs, the variations in the conditions of administration, the types of subjects, and the varieties of dependent variables are excessively great. Since this unit is the first of what will doubtless be a series of reviews, we have taken as our prime task the introduction of the reader to some of the efforts which are encompassed within psychopharmacology. We will attempt, in passing, to point to the major recent reviews, reports, and volumes which have been published, in addition to the journal literature.

Although the term "psychopharmacology" has been used with increasing frequency over the past few years, the concept is by no means new to psychology. Studies on the effects of drugs on the behavior of animals go back to the previous century. In the human area, the classic investigations of the effects of caffeine on behavior were carried out by Hollingworth (70) in the first decade of this century. This series of studies embodied many of the aspects of good design and may still have value as a model for the analysis of the effects of drugs on human behavior. The major experimental literature for almost the first 40 years of this century can be encompassed in the reviews by Poffenberger (104), Robinson (110), Meyer (97), Darrow (29), and Shock (116) which appeared in the *Psychological Bulletin*. From the pharmacological viewpoint, the 1941 edition of the standard textbook on pharmacology by Goodman & Gilman (51) covered the literature on the effects of drugs on human behavior for the same time period. The fourth edition of the widely used textbook in pharmacology by Krantz & Carr, published in 1958 (84), is the first such textbook to contain a major section on psychopharmacology. The subject is treated under the heading "The Use of Drugs in the Treatment of the Mentally Ill."³

¹ This review covers the period from 1954 to April, 1959.

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³ From his reading of a draft of this report, Joseph Zubin suggested that the authors could have taken their historical treatment back to Kraepelin, who attempted

Although psychology has been concerned with the effects of drugs on behavior of both animals and human subjects for many years, the current dramatic expansion of interest in psychopharmacology as a special area dates from about 1953. In its early phases it was a product of the interaction between pharmacologist and psychiatrist. This interaction occurred in the modification of the behavior of psychiatric patients.

RESERPINE, CHLORPROMAZINE, AND MEPROBAMATE

The first three drugs to be extensively used in clinical treatment were reserpine, chlorpromazine and meprobamate. Reserpine is an alkaloid derived originally from the root of *Rauwolfia serpentina* and is primarily responsible for the pharmacological effects of powdered preparations made from the root of this plant. Powdered *Rauwolfia* had been used by Hindu physicians for centuries in the treatment of a variety of conditions, including insomnia and psychiatric illness (77). Its use in modern western medicine, however, was initiated by internists who were interested in its hypotensive effect and its therapeutic usefulness in the treatment of hypertension. In 1951 Wilkins & Judson (131), internists, noted its beneficial effect in anxious, tense patients in the course of clinical studies of its utility as a hypotensive agent. In 1952 it was noted by a veterinarian in the laboratories of the American branch of the Ciba Pharmaceutical Company to exert a remarkable taming effect upon the hostile agitated behavior of the rhesus monkey. It was then tested by Kline (77) at Rockland State Hospital in the treatment of disturbed psychotics. He ran a well-controlled study with separate groups of patients on, respectively, reserpine, whole *Rauwolfia* root, and inert placebo. Although the response of the treated patients was not sufficient to be noted by the clinical staff, statistical analysis of the numbers of hours spent by the patients in the various treatment groups in seclusion, restraint, or both, revealed that both pharmacological agents had a definite effect in reducing disturbed behavior. Further controlled studies in which larger doses of this drug were used have generally confirmed this observation. Those studies using dosages of greater than 5 mg. per day have shown consistent positive results. Those using smaller doses for short periods of time are often inconclusive.

Chlorpromazine, a phenothiazine derivative, was developed by a French pharmaceutical firm as an antihistaminic. Despite its relatively weak antihistaminic properties, it was employed by Laborit, Huguenard & Allaume (87) as one of several drugs in a "lytic cocktail," a melange of chemical agents designed to block both sympathetic and parasympathetic systems in patients undergoing traumatic surgical shock. Clinical observations that these patients showed an unusual indifference and lack of anxiety led Delay,

to produce psychotic-like behavior in normals. Kraepelin spent some time with Wundt. The authors could have thus made a pertinent point on the historical and current relationships between psychiatry and psychology.

Deniker & Harl (31) to try chlorpromazine in the treatment of manic and schizophrenic excitements. The results were striking. These early uncontrolled studies have been, in general, confirmed by subsequent controlled studies, although occasional clinical trials in which were used very chronic patients and relatively low doses of the drug have not been able to demonstrate a significant therapeutic effect. The role of clinical serendipity in the discovery of both of these compounds is apparent.

The third of the new psychopharmacological agents to be discovered, meprobamate, was developed through a more rational pharmacological process. Berger was interested in developing a longer-acting compound similar to mephenesin (11), a substance with very short acting central muscle-relaxant properties. Meprobamate (12) was one of a series of related compounds synthesized in the course of this search. Although this drug does have some muscle-relaxant properties, the relevance this bears for its clinical actions is by no means clear. The compound is certainly a sedative. Preliminary uncontrolled studies of its effectiveness in psychiatric outpatients have led to its widespread clinical use. The superiority of this compound to barbiturates and other drugs generally considered to be sedatives has not been firmly established yet (86). Meprobamate can be reliably differentiated from the barbiturates at the animal level by certain neuropharmacological techniques.

NEW COMPOUNDS

In the period since 1954, when meprobamate appeared, a variety of other compounds has been developed by the pharmaceutical industry. These compounds, their generic names, their trade names, and the company producing or distributing them are listed in Table I. Those compounds not yet released by the Food and Drug Administration for general prescription use are denoted by an asterisk. Ten of the compounds listed in Table I are phenothiazine derivatives chemically related to chlorpromazine. None of these has been demonstrated to be definitively superior to chlorpromazine in adequately controlled clinical investigations, but many experienced clinicians believe some of them to be significantly more potent than chlorpromazine. Several of these phenothiazine derivatives, prochlorperazine, perphenazine, triflupromazine, and thiopropazate, are judged to have considerably less sedative action than chlorpromazine (50) and may have other advantages in the treatment of psychiatric conditions. A number of compounds chemically similar to reserpine have also been developed. Again, none of these except deserpidine has been demonstrated to be as effective as reserpine. In a very carefully designed controlled study by Turner *et al.* (125), this compound has been shown to be as effective, but not more effective, than reserpine, although the newer drug is effective at a substantially lower dose.

A variety of other compounds, some chemically similar to meprobamate and others generally different from it, have been claimed to have potency in the

treatment of neurotic symptoms. Again, none of these compounds has been conclusively demonstrated to be superior either to the barbiturates or to a placebo, and the sizeable spontaneous improvement rate in psychoneurotic outpatients under any treatment procedure still leaves the exact clinical status of these compounds open to question. It is interesting to note, as a harbinger of things to come, that controlled studies of drug effects on psychological functions in normal subjects have demonstrated conclusively that there are differences in psychopharmacological activity between various tranquilizers. Work by Lehmann & Czank (89) and by DiMascio *et al.* (35) have respectively differentiated between chlorpromazine and prochlorperazine and between phenyltoloxamine and reserpine in normal subjects.

In the last year and a half a different group of compounds have made their appearance in the literature and in the clinical practice of psychiatry. The first of these, iproniazid, has been claimed on the basis of a considerable number of uncontrolled clinical studies (122) to have a specific and potent effect in the treatment of depressive states, particularly psychotic depressions. Its activity is believed to be related to its effect as an inhibitor of monoamine-oxidase. The enzyme, monoamine-oxidase, plays a role in the metabolism of a variety of catechol amines, including epinephrine, norepinephrine, and serotonin. The relationship between this pharmacological action of iproniazid and its clinical effect has by no means been formally demonstrated. Nevertheless, a variety of other monoamine-oxidase inhibitors with a variety of chemical structures are being developed by various companies; several of these are undergoing preliminary clinical trials. One, phenelzine, has just been released for prescription use. Clinical reports on several of these were presented at a recent meeting held by the New York Academy of Medicine and should appear in published form sometime in 1959.

Another compound, imipramine, structurally related to chlorpromazine, but not a phenothiazine, has been studied clinically by Kuhn in Europe and Lehmann in Canada in the treatment of depression. It is not a monoamine-oxidase inhibitor, and is allegedly not a stimulant, but is described as having a potent therapeutic effect in the treatment of psychotic depressions. Both this drug and iproniazid are often said not to produce a therapeutic effect for periods ranging from three days to several weeks. This apparent pharmacological lag strongly underlines the need for careful, controlled studies of both compounds before their real therapeutic potential can be reasonably established.

PSYCHOTOMIMETIC AGENTS

The fourth group of compounds are the psychotomimetic agents listed in Table II. Only some of these compounds have been developed by pharmaceutical houses. Others are isolated from natural products or have been prepared through special synthesis in academic laboratories. A variety of naturally occurring substances have been used by many tribes for the promotion of peculiar states often accompanied by vivid hallucinations and strong feelings of unreality and depersonalization. Of these, mescaline, the

active principle of peyote, has been the best studied. In 1947 a synthetic chemical, lysergic acid ethylamide-25 (LSD-25) was discovered to have similar properties (120, 121). The extensive literature on these substances, unfortunately, tells one relatively little about the relationship of the states induced by these drugs to actually occurring schizophrenia and relatively little about the specific psychopharmacological properties of these agents.

New psychotomimetic compounds of major psychopharmacological interest have emerged recently. One group of compounds, benzylalkylamines synthesized by Biel at Lakeside Laboratories and tested chiefly by Abood, Ostfeld & Biel (1), has been demonstrated to have potent psychotomimetic properties. The reaction produced by these compounds is said considerably to exceed in severity that produced by LSD-25. There is apparently a mild euphoria experienced by normal subjects, which lasts several weeks after a single administration of these compounds. All of the above agents produce visual, and sometimes auditory, hallucinations. A new chemical, 1-phenyl-1-(1-piperidyl) cyclohexane (Sernyl), originally developed as an anesthetic, is quite dissimilar from the other psychotomimetics in chemical structure, appearing to produce a disorganization of thinking, severe alteration in body image, and severe feelings of unreality without producing either auditory or visual hallucinations (95).

It can readily be seen from the brief description of new drug developments in psychopharmacology that the rate at which new interesting compounds are produced far exceeds the ability of existing research facilities adequately to evaluate and assess their properties psychologically, pharmacologically, or clinically.

As can be readily concluded, there are a large number of drugs actually in use with psychiatric patients or in process of development for such use. In most ways it is this potential clinical application which has formed the background of the current interest in psychopharmacology. The entry of the psychologist into this broad field of interest is an important and increasing fact. The psychologist can significantly contribute to the facets of drug development, animal testing, technique development, methodological analysis, and assessment of effectiveness.

In the *Annual Review of Psychology*, Volume 8 (1957), Stellar (119) opened the general area of psychopharmacology with a brief discussion. He stated some critical problems: (a) Are there any statistically significant and practical effects on behavior in general and mental disturbance in particular? (b) Where do these drugs act in the nervous system and what kinds of neurophysiological effects do they produce? and (c) How do these drugs exert their effects? These are real questions. We shall centrally deal with the first question in this review.

CONFERENCES, REVIEWS, AND BIBLIOGRAPHIES

In the period since the advent of chlorpromazine and reserpine, there has been an increasing, and at times almost overwhelming, number of conferences dealing with various aspects of psychopharmacology. Some of these

have revolved primarily around a single drug; others have consisted of a melange of basic and clinical papers covering a variety of topics. Some conferences have been primarily concerned with the basic mechanisms of drug action, while others have dealt primarily with methodological problems involved in the study of drugs.

The conferences concerned with single drugs began with the New York Academy of Sciences meeting on the "Chemistry, Pharmacology, and Clinical Applications of Reserpine and other Alkaloids of *Rauwolfia serpentina*" (133). This meeting was followed by a second conference on reserpine, concerned chiefly with the drug's effects on the central nervous system and its use in the treatment of neuropsychiatric and neurological conditions (134). Also in 1955, the results of a symposium on chlorpromazine were published, entitled *Chlorpromazine and Mental Health* (23). The conference was mainly clinical in orientation. In 1957, the proceedings appeared (13) of a conference on meprobamate held under the auspices of the New York Academy of Sciences and, in the same year, a Regional Research Conference held by the American Psychiatric Association gave special attention to a group of papers on prochlorperazine (80). The proceedings of a conference on the biochemical and clinical effects of iproniazid and other monoamine-oxidase inhibitors (122) were published in 1958.

Two other Regional Research Conferences held by the American Psychiatric Association have concerned themselves with both basic and clinical studies of a variety of psychopharmacologic agents. They have been published as *Psychiatric Research Reports Nos. 1* (53) and *4* (54). The proceedings of two similar conferences held by the American Association for the Advancement of Science have also been published. The earlier of these, entitled *Psychopharmacology* (78) appeared in 1956; the second, *Tranquilizing Drugs*, (68) appeared in 1957.

Several volumes containing the proceedings of several conferences concerned with basic mechanisms of drug action have also appeared. These include the three Macy conferences on neuropharmacology (2, 3, 4), published respectively in 1955, 1956, and 1957 (the fourth has appeared too late for inclusion in our reference list) and a New York Academy of Science conference, *The Pharmacology of Psychotomimetic and Psychotherapeutic Drugs* (75). *Psychotropic Drugs* (49) is larger in scope as well as size, containing the proceedings of an international symposium on psychotropic drugs held in Milan, Italy, in May, 1957. This volume contains a considerable number of articles by European investigators, some articles in English and some with English summaries. At another international meeting, the Second International Conference of Psychiatry, held in Zurich, Switzerland, September, 1957, a psychopharmacology symposium was held. The proceedings of this symposium have been published under the title *Psychopharmacology Frontiers* (79). Papers included cover a variety of topics ranging from the theoretical to the clinical. A résumé of the conference held by the Association for Research in Nervous and Mental Disease has appeared in a volume entitled, *The Effect*

of *Pharmacologic Agents on the Nervous System* (14); it, too, covers a variety of historical, pharmacological, methodological, and clinical topics.

A symposium devoted exclusively to the consideration of methodological problems in the evaluation of psychoactive drugs at both the basic and clinical levels has recently appeared as *Psychopharmacology: Problems in Evaluation* (27). Results of a similar conference dealing primarily with methods for the evaluation of drug effects on animal behavior were published in 1956 (33). A major conference dealing with the problems of psychopharmacological research with children was held in 1958. This meeting considered the many phases of effects of drugs from a developmental point of view; its report should appear shortly (44).

A highly detailed, well-indexed bibliography covering all publications in psychopharmacology for the period between 1952 and 1957 has appeared under the title, *Psychopharmaca* (18). Volume 4 of the *Handbook of Toxicology* (56) contains summaries of the chemical characteristics, pharmacology, and toxicity of 26 psychotherapeutic agents. A similar volume, *Psychotherapeutic Drugs* (127), covers the same area but has a somewhat more clinical-dermatological slant.

A relatively extensive, critical review of the literature on drugs and performance, by Trumbull & Maag (124), appeared in August, 1958. The annotated bibliography of almost 200 selected papers has been carefully compiled providing an excellent source on these problems. Wikler (129) has published the most extensive and careful review of the field yet to appear. He has covered the period from 1930 to 1955, concerning himself with the biochemical, psychological, and clinical effects of drugs used in the treatment or study of "functional" behavior disturbances. As can be seen, there has been a great deal of meeting and publishing activity, which demonstrates the interest in this area and underlines the need for extensive, reliable, and useful information on drug effects.

DRUG EFFECTS ON HUMAN BEHAVIOR

Methodological considerations.—Methodological problems which relate to the assessment of drug effects in human subjects have been of compelling interest to many scientific workers in this field. For example, the volume edited by Cole & Gerard (27), mentioned above, contains major analyses of the problems of the evaluation of drug effects in human and animal subjects. Some of the problems of reporting of studies of psychiatric drugs and some of the needs in the improvement of this literature have been detailed in the report by Cole, Ross & Bouthilet (28), while some of the research problems of the clinical evaluation of drugs have been treated by Cole (25). Ewing *et al.* (37) considered the trends in research in human psychopharmacology, and Faurbye (43) considered some principles of experimental pharmacotherapy. Kubie (85) has considered the problems of psychopharmacology from the point of view of clinical psychoanalysis. The 1958 issue of the *Annual Review of Medicine* contained an excellent review by Lasagna & Meier (88) which

dealt with the clinical evaluation of drugs. Leveton (90) has been interested in the problems of the evaluation and testing of psychopharmaceutic drugs, while a new contribution by Wikler (130) to the methodological problems in drug analysis has appeared. We have already made reference to the work of Trumbull & Maag (124).

Some reports have appeared which deal with the experimental or statistical aspects of drug evaluation. A new methodological approach was described in 1956 by Gottschalk *et al.* (55). The application of sequential analysis to the therapeutic research situation has also been made by a group at the University of Oklahoma (36, 57). Cass & Frederik (22) have been interested in experimental and statistical problems as applied to the study of new drugs.

The general problem of the design and conduct of drug studies has been treated in a recent paper by Nash (100), in which the multiple important variables are considered. This paper is an excellent treatment of the manifold problems.

A study of two phenothiazine compounds, thioridazine and KS-75,⁴ in outpatients (45) was published by a Minnesota group, using the Q-technique⁵ and the Minnesota Multiphasic Personality Interview (MMPI) in a double-blind design. This study has many features to recommend it as a model.

An excellent critical analysis of the studies of the efficiency of meprobamate in the treatment of anxiety has been produced by Laties & Weiss (86). No firm evidence is found to indicate that meprobamate is superior to barbiturates or to a placebo in the management of outpatient neurotics. Heilizer (65) has produced a critical, detailed analysis of the psychiatric and psychological literature dealing with chlorpromazine. This analysis is a most useful one, and, when published, will be a valuable addition. Sainz, Bigelow & Barwise have been interested in the rapid clinical evaluation of psychiatric drugs (113, 114), and Wittenborn & Kline (132) have been interested in the use of emergent behavior in psychiatric and drug research. A recent paper by Tuteur (126) deals with the pitfalls and fallacies involved in the "double-blind" method for studying drug effects. Foulds (46) has published an acidic attack on most of the published clinical research dealing with the effectiveness of drug and nondrug therapies in psychiatry. He demonstrates that there is a significantly greater chance for positive results to be obtained from uncontrolled rather than from controlled studies.

Experimental studies.—The task of the reviewer attempting to bring order out of the increasing number of discrete studies dealing with the effects of drugs on psychological functioning and behavior in man is hindered by the very nature of the available scientific material. Many studies use several drugs and several measures of behavioral effect. Few attack the problem in such a way as to make direct comparison between studies feasible in any well-organized manner. Ordering articles by individual drugs or by psychological

⁴ 2-isopropoxy-10-[2-(N-methyl-2-piperidyl)ethyl]phenothiazine.

⁵ A technique for correlating persons.

variables would make for excessive repetition of methods and findings, or of drugs. The reader must, therefore, bear with us in the description of a number of individual studies which are not placed within a logical framework.

Lehmann & Czank (89) studied the effects of a variety of drugs (caffeine, d-amphetamine, secobarbital, chlorpromazine, prochlorperazine, and reserpine) on a test battery of perceptual and motor tasks. Differential drug effects were found on after-image sensitivity, tapping speed, critical flicker frequency, reaction time, hand steadiness, and cancellation time. Caffeine and amphetamine produced significant gains in tapping speed and digit symbol performance, as well as decrements in cancellation time. Amphetamine and caffeine decreased reaction time; they increased after-image sensitivity and cancellation scores. Hand steadiness showed a decrement with caffeine. Secobarbital significantly reduced critical flicker frequency, after-image sensitivity, tapping speed, hand steadiness, digit recall, and cancellation scores. Reaction time was significantly increased with secobarbital. Reserpine increased after-image sensitivity significantly, while chlorpromazine and prochlorperazine produced the most marked stimulant effects. A marked decrease in reaction time and significant improvements in hand steadiness, digit span, digit symbol, and cancellation scores were observed.

A study was reported by Benjamin, Ikai & Clare (10) which dealt with the effects of single doses of prochlorperazine and phenobarbital and of a no-medication condition on a variety of performance measures in a double-blind arrangement. Decrement in muscular co-ordination performance was found when normal subjects were used.

Hess & Jacobsen (66) have studied the effects of benactyzine hydrochloride on reaction time. This drug increased reaction time, variability, and the number of errors. A second study (67), mainly dealing with electroencephalogram (EEG) effects, was also published.

Schneider & Costiloe (115) reported on the effects of centrally active drugs on conditioning in human subjects. The authors were interested in spontaneous recovery and reconditioning of the galvanic skin response. Amobarbital inhibited spontaneous recovery and had a slight tendency to inhibit reconditioning. Chlorpromazine hydrochloride inhibited reconditioning, but did not alter spontaneous recovery. Methylphenidate hydrochloride facilitated reconditioning, but did not alter spontaneous recovery. Interpretations are made in terms of alterations in tension and anxiety in the subjects.

A study reported by Holliday, Duffy & Dille (69) dealt with the effects of meprobamate, chlorpromazine, pentobarbital, and placebo in normal subjects on tracking behavior under stress and threat of stress conditions. When compared with placebo, meprobamate reduced the total tracking time and also the number of times subjects were off-target during the nonpunishment threat condition. The other drugs did not yield any significant differential effects under the two experimental conditions.

An excellent series of studies on drug effects on behavior have been appearing over the past five years from the United States Air Force School of Aviation Medicine. Concerned initially with the problems of the mitigation

of work decrement (59), these studies have continued testing the effects of a variety of drugs on performance (60 to 63). The researches are outstanding as effective attacks on some of the complexities of the measurement of drug effects on human performance and on some of the nondrug factors influencing such performance.

Payne (102) studied the effects of promethazine hydrochloride and placebo on paired-associates learning in normal subjects. The drug effect was much less pronounced when overlearning was present than when it was not present, but the effect was more pronounced with changed, rather than with original, word order.

Laties & Weiss (86) investigated the effects of meprobamate on fear and palmar sweating in normal subjects taking a Ferris-wheel ride. Stress produced by the ride increased palmar sweating. The number of subjective emotional responses decreased under meprobamate, while fear rating remained unaffected. Meprobamate produced a decrease in palmar sweating. This finding disagrees with the report of Marquis *et al.* (96) on the effects of meprobamate, amphetamine, and alcohol on a number of performance tests, such as the American Automobile Association driver-trainer reaction time, visual measures, and steadiness. Meprobamate, in a single dose of 800 mg., gave evidence of having no effects on these tests. A comparative study of phenaglycodol, meprobamate, and placebo was carried out by Reitan (109). He used normal and outpatient subjects. Normal subjects performed better on the placebo than on either drug, while with the patients no significant differences between placebo and either drug were found. The performances measured were visual time-sense, finger tapping, simple reaction time, discrimination reaction time, and the Spokes test.

Funkenhaeuser (47, 48) has reported two studies dealing with the effects of a number of drugs: quinine, caffeine, pentobarbital, and methamphetamine hydrochloride on time estimation.

The effects of chlorpromazine, secobarbital, and LSD have been investigated on a series of measures of psychomotor and intellectual performances by Kornetsky, Humphries & Evarts (83). Placebo controls and a double-blind method were used. Chlorpromazine and secobarbital impaired digit-symbol and pursuit-rotor performance. Chlorpromazine, at the higher of the two dosage levels used, significantly impaired performance on all of the measures. LSD lowered scores on the intellectual task, but did not seem to impair co-ordination. These workers could find no support from their results for the existence of a tranquilizing action of chlorpromazine independent of its sedative effects. A later study by Kornetsky & Humphries (82) compared effects of 100 and 200 mg. dose levels of chlorpromazine and of secobarbital on several behavioral and physiological measures. Chlorpromazine produced greater performance impairment than did secobarbital. In most of the tasks involving motor coordination, 100 mg. of chlorpromazine elicited greater impairment of performance than 200 mg. of chlorpromazine. In another study by Kornetsky (81), the interest was in the effects of meprobamate,

phenobarbital, and dextro amphetamine sulfate on reaction time and learning. The study showed that meprobamate at 1600 mg. significantly impaired motor coordination and reaction time, and at 800 and 1600 mg. the rate of learning was affected. These results can be compared with a study by Kelly *et al.* (74), in which no adverse effects of meprobamate or prochlorperazine were found. Loomis & West (94), using a simulated driving apparatus, reported that performance was impaired by secobarbital, meprobamate, and chlorpromazine.

The effects of drugs on verbal behavior, emotion, and communication processes have not escaped research emphasis. No review, whatever its emphasis, can consider itself appropriate without a mention of the pioneering efforts of the Rochester group in regard to the analysis of drug effects. In this instance attention should be directed to the 1953 report on development of methods and the preliminary findings on emotional and social behavior (58). The principles and the problems of the evaluation of the subjective effects of drugs have been developed clearly and vigorously in the now classic papers by Beecher (8, 9).

Several recent experimental investigations have provided interesting leads and techniques: Kahn & Fink (73); Rothman & Sward (111); and Tourlentes, Hunsicker & Hurd (123). These studies follow the beginnings made in the analysis of these behaviors by such work as that of Steinberg (118), Nowlis & Nowlis (101), and Clark & Beecher (24). The needs for careful investigations of the effects of drugs on these aspects of behavior are obvious. Unfortunately, the difficulties are many. We hope for more study here.

The great importance of personality factors in regard to drug effects has been critically treated recently by DiMascio & Klerman (34), by DiMascio *et al.* (35), and by Klerman *et al.* (76) in a model study dealing with the evaluation of a new agent, phenyltoloxamine.

An attack on the problem of the control and evaluation of social factors in drug research has been made by Rashkis & Smarr (108), while two studies, by Perlin, Pollin & Butler (103) and Pollin & Perlin (105), have appeared dealing with the problem of the "volunteer."

Among other approaches to the study of drug effects on human learning and performance is the recent study by Whitehead & Thune (128) dealing with the effects of chlorpromazine on learning in chronic psychotics. The measures involved pursuit rotor performance, verbal learning measures, problem solving, and social adaptation. Mirsky, Primac & Bates (98) have reported on the detrimental effects of chlorpromazine on performance on the "continuous performance test." Porteus (106) and Porteus & Barclay (107) have studied the effects of chlorpromazine on Porteus maze responses. Major deteriorative effects of chlorpromazine are found.

Heilizer (64) studied the effects of chlorpromazine on psychomotor behavior in chronic schizophrenic patients, employing measures of reaction time and finger dexterity, Bender-Gestalt, etc. The effects of drugs on attention span has also been of recent interest (20, 21, 30). Kornetsky and

associates, in a recent study, have been especially interested in the effects of acute medication of chlorpromazine in schizophrenic patients. The performances measured were the modified digit-symbol test (Wechsler), pursuit rotor, tapping, and recognition of numbers under tachistoscopic presentation. Significant impairment is reported at 200 mg. dose level on pursuit rotor, tapping speed, and digit symbol.

A major series of studies has been reported by Eysenck and his collaborators. The general theoretical attack links the action of depressant and stimulant drugs with cortical inhibition and cortical excitation. These studies have made use of dextro amphetamine sulfate (Dexedrine), sodium pentobarbital, and a placebo. The statement of the theoretical approach and the methodological problems was presented by Eysenck (38). Reports have appeared testing specific hypotheses derived from the general theory. Eysenck & Aiba (39) have studied the effects of stimulant and depressant drugs on the suppression of the primary visual stimulus. Eysenck, Casey & Trouton (40) have reported on the effects of stimulant and depressant drugs on continuous work. Visual after-effects (41) and reversible-figure rate of fluctuation (42) have also been investigated. The approach of Eysenck and his collaborators is theoretically derived and comprehensive. We continue to await the further studies in this program.

Two studies on the effects of amphetamine and amobarbital (Amytal) have been reported (15, 16). They deal with memory, expressive movements, and certainty in recall and recognition.

Some new developments promise to become useful ways of analyzing the effects of drugs on humans. An example is the report by Dews (32) on the effects of *D*-amphetamine on operant behavior in the normal human subject. Burch & Greiner (17) have been interested in galvanic skin response parameters of drug and fatigue effects, while Smith, Harris & Shideman (117) have extended aspects of dynamic motion analysis to the effects of alcohol.

Callaway (19) has been interested in the application of information theory in psychopharmacology.

Moran & Mefferd (99) have developed a promising set of psychometric measures designed for repetitive administration. If this instrument is successful, it can be invaluable in drug assessment.

A series of studies has been reported by Abramson, Hirsch, Jarvik and others on LSD effects on normal human subjects. LSD has been found to affect adversely spatial relations abilities (5); recall and recognition (except for digit span and nonsense-syllable recognition), and simple and complex types of cancellation tasks (71); performance on a pursuit rotor and a Dunlap steadiness test (6); performance requiring the ability to manipulate numbers (72); and ability to abstract, concentrate, and shift set on the Wechsler-Bellevue Intelligence Scale (91). LSD did not impair performance on the Bender-Gestalt test (7). The wide interindividual differences which are found in response to LSD must be emphasized, and so must the general

finding that observed effects, if any, are of a deleterious nature. Two recent studies dealing with the effects of LSD on perceptual processes should be identified (92, 93). A review was published on the psychopharmacology of LSD-25 by Rubin (112).

BEHAVIORAL PHARMACOLOGY

Over the past fifty years pharmacology, like other sciences, has borrowed methods from many other disciplines, such as biochemistry, physiology, pathology, and bacteriology. These methods have been adapted and modified to expand our knowledge about the mechanisms through which drugs act and to develop better procedures for the identification of new or improved chemical agents for the treatment of a variety of clinical conditions. In its early development, psychopharmacology was primarily the province of the psychiatrist and the pharmacologist, each using techniques developed before the advent of the newer psychoactive drugs. It is interesting to observe the increasing involvement of the psychologist in psychopharmacology and the increasing use of psychological methods in studies of mechanisms of drug action, in the development of new approaches to drug screening, and in adding quantification and experimental rigor to the work of the clinician studying the effects of new drugs on psychiatric patients. We are still a long way from having a "pharmacology of behavior" which can tell us as much about the effects of drugs as general pharmacology can tell us about the effects of some drugs on other physiological systems and other disease entities. Nevertheless, the outlines of such a pharmacology of behavior can be seen in its starting shape, and the important role of the psychologist in this development is assured.

In the meanwhile, there are only fragments of information available. In this review we have described some of these pieces. From a pharmacological point of view, general comments may be in order. In general, only few of the available drugs are widely studied. When they are investigated in experimental situations, generally limited information is available on the dose-time-response functions. Frequently the mode of administration is not systematically varied, and, at best, only a few behavioral response measures are studied. Most often only acute studies are performed. Such obvious weaknesses seriously limit the generalizability of any of the reported drug-behavior relationships.

Those psychologists who are working extensively with the effects of drugs on animal and human behavior have become increasingly aware that a drug is not by any means a simple, independent variable which may be inserted into any research design or into any subject. Not only must such drug properties as dosage, time of maximum effect, and route of administration be considered, but many drugs have special peculiarities which make it difficult even to compare drug A with drug B. Reserpine and iproniazid, for example, reach a peak effect only if administered over a period of days. The pharma-

cological effect appears to wear off slowly. This property may make impossible their use in crossover and other Latin square designs. In addition, pretreatment with even a single dose of iproniazid will cause a subsequent single dose of reserpine to produce a stimulant rather than a depressant effect even several weeks later. Chronic administration of chlorpromazine may also produce a continuation of drug effects for a considerable period after dosage is stopped.

With many of the psychotomimetics, on the other hand, tolerance to the psychological effects appears to be so rapidly developed that individual doses must be separated by several days if reproducible results are to be obtained. Tolerance may also be developed to some of the sedative effects and the detrimental psychomotor effects of some of the psychiatric drugs.

Another problem, well documented in the clinical literature, is the very great variability in the response of patients to the same drug. It may, for example, take only 100 mg. of chlorpromazine effectively to control disturbed psychotic behavior in one patient, while another patient may require 3000 mg., and a third may be unaffected by 5000 mg. There is also some evidence that the direction of drug response, as well as its magnitude, may vary with the pre-existing personality of the subject. The social situation may also powerfully influence drug response, as everyday observations on the varying effects of so old a psychopharmacologic agent as alcohol can readily demonstrate. Different actions of a single drug may interact in a manner which may complicate apparently straightforward studies. A phenothiazine derivative might, for example, impair performance by producing minimal Parkinsonian muscular rigidity as a side effect. The net effects of a single dose level over a group of normal subjects might well vary sizeably because of interindividual variability, both in anxiety level and in central nervous system sensitivity to the Parkinsonism-inducing properties of the drug.

Another pitfall in psychopharmacology is the potential danger in attempting to base theories concerning mechanisms of drug action in psychiatric patients on observation of even ideally designed studies of drug effects in normal subjects.

Behavioral pharmacology, however interesting, requires more than the direct addition of a drug to a psychological test situation. Since drug effects can be either beneficial or detrimental to the economy of a subject, behavioral pharmacology brings with it the related area of behavioral toxicity. The study of adverse effects of drugs on behavior has been discussed more fully elsewhere (26). It differs from studies of the mechanisms of drug action or of clinical drug effectiveness in the value judgement placed on the drug effects under consideration. The psychologist can certainly contribute significantly to our knowledge of potentially undesirable drug actions, although the application of these findings remains as the province of the clinician.

CONCLUSION

We have attempted in this review to present an overview of the current efforts which are taking place in experimental human psychopharmacology at the present time. We have tried to place these efforts in the historical context in which this research is being done. In view of the magnitude of this total effort, we have concentrated on the American literature, and have dealt primarily with the human studies. We have little doubt that the prime application of drugs at the present time is in the clinical setting, and the concern and call for new drugs come from the need for better treatments for psychiatric patients. There are some new notions which have appeared and which we have stressed. The study of drug effects on "normal" human subjects has been a major emphasis. Attempts to determine the effects of drugs on perceptual and motor performance of subjects are basic to the growing science of behavioral pharmacology. The increasing concern with personality and social determinants of drug effects is of equal importance. In a recent address to the Research and Development Section of the Pharmaceutical Manufacturers Association, Neal Miller stressed the basic value of the analysis of drug effects on motivational processes to a science of psychopharmacology. We agree heartily.

There are at least two major areas with which we have not attempted to deal in any detail. The first is the area of the clinical effectiveness of drugs. The second is the major and important developing body of knowledge concerning drug effects on animal behavior. The magnitude of both these topics was too great to be added to the portion of the Annual Review allotted to us. We hope that future reviews in this series will deal with these areas of major interest to psychologists, pharmacologists, and psychiatrists.

We have treated the area of psychopharmacology as one replete with new questions regarding the effects of drugs on human behavior. We have not found in our analysis that drugs have provided new and sharp answers to old problems of psychology, but we have found an increasing volume of work aimed at determining the effects of drugs. The increasing interdisciplinary sophistication and the use of an increasing variety of new methods and theoretical approaches augur well for a productive future for psychopharmacology. The skills and methods of the psychologist must be intelligently combined with those of the pharmacologist, the biochemist, the neurophysiologist, and the psychiatrist. If adequate amounts of effort, imagination, research support, and tolerance for transient confusion and occasional failure are provided, future reviews covering this area should find increasing order in the field. We anticipate such evidence of the growth of a fascinating and important body of scientific knowledge.

TABLE I
PSYCHOPHARMACOLOGIC AGENTS

Generic Name:	Trade Name:	Available From:
MAJOR TRANQUILIZERS		
<i>Phenothiazine Derivatives:</i>		
chlorpromazine	Thorazine	Smith, Kline & French
mepazine	Pacatal	Warner-Chilcott
perphenazine	Trilafon	Schering
prochlorperazine	Compazine	Smith, Kline & French
promazine	Sparine	Wyeth
thiopropazate	Dartal	Searle
triflupromazine	Vesprin	Squibb
trifluoperazine	Stelazine	Smith, Kline & French
thioridazine*	Mellaril	Sandoz
<i>Rauwolfia Alkaloids:</i>		
reserpine		Many firms
deserpidine	Harmonyl	Abbott
rescinnamine	Moderil	Pfizer
11-desmethoxyreserpine*	Raunormine	Lederle
MINOR TRANQUILIZERS		
<i>Phenothiazine Derivatives:</i>		
promethazine	Phenergan	Wyeth
methoxypromazine*	Tentone	Lederle
<i>Diphenylmethane Derivatives:</i>		
azacyclonol	Frenquel	Merrell
benactyzine	Suavitil	Merck, Sharp & Dohme
hydroxyzine	Atarax	Roerig
phenyltoloxamine	PRN	Bristol
<i>Substituted Diols:</i>		
meprobamate	Equanil, Miltown	Wyeth, Wallace
phenaglycodol	Ultran	Lilly
oxanamide	Quiactin	Merrell
ANTIDEPRESSIVES (Stimulants)		
orphenadrine	Disipal	Riker
iproniazid	Marsilid	Hoffmann-La Roche
pipradrol	Meratran	Merrell
methylphenidate	Ritalin	Ciba
deanol	Deaner	Riker
amphetamine	Benzedrine	Smith, Kline & French
d-amphetamine	Dexedrine	Smith, Kline & French
desoxyephedrine (Methamphetamine, U.S.P.)		Many firms
imipramine*	Tofranil	Geigy
phenelzine*	Nardil	Warner-Chilcott
nialamide	Niamid	Pfizer
phenylisopropylhydrazine*	Catron	Lakeside

TABLE I—(continued)

Generic Name:	Trade Name:	Available From:
<i>NONBARBITURATE SEDATIVES</i>		
<i>Miscellaneous Chemical Structure:</i>		
ethchlorvynol	Placidyl	Abbott
methylparafynol	Dormison	Schering
ethinamate	Valmid	Lilly
glutethimide	Doriden	Ciba
methypylon	Noludar	Hoffman-La Roche
ectylurea	Nostyn	Ames
oxanamide	Quiactin	Merrell
captodiamine	Suvren	Ayerst
<i>NONHYPNOTIC CENTRAL-MUSCLE RELAXANTS</i>		
chlormethazone*	Trancopal	Winthrop
styramate*	Sinaxar	Armour
chloroxazone*	Paraflex	McNeil
carisoprodol*	Soma	Wallace
dioxolane	Dimethylane	National

* New drug, not available for general prescription use at the time of writing.

TABLE II
PSYCHOTOMIMETIC AGENTS

Chemical Name	Symbol, Generic or Trade Name
<i>d</i> -lysergic acid diethylamide	LSD-25
<i>d</i> -lysergic acid monoethylamide	LAE-32
<i>d,l</i> -acetyl lysergic acid diethylamide	ALD-52
N,N-dimethyl-5-hydroxy tryptamine	bufotenine
N,N-dimethyl tryptamine	DMT
((6 methyl-4,5-pyrido)2,3)-9-methoxy indole	harmine
2-diethylaminoethyl cyclopentyl(2-thenyl)glycolate	Win-2299
3,4,5-trimethoxyphenylethylamine	mescaline
3,4,5-trimethoxyphenyl- β -aminopropane	3,4,5 TMA
oxidation products of adrenaline	adrenochrome, adrenolutin
N-allylnormorphine	nalorphine, Nalline
N-ethyl-3-piperidyl benzilate	JB-318
N-ethyl-3-piperidylcyclopentylphenyl glycolate	JB-329, Ditran
1-(1-phenylcyclohexyl) piperidine	Sernyl
ortho-phosphoryl-4-hydroxy-N-dimethyl tryptamine	psilocybin

LITERATURE CITED

1. Abood, L. G., Ostfeld, A. M., and Biel, J. A new group of psychotomimetic agents. *Proc. Soc. Exptl. Biol. Med.*, **97**, 483-86 (1958)
2. Abramson, H. A. (Ed.) *Conf. on Neuropharmacology, Trans. 1st Conf., Princeton, N. J., 1954*
3. Abramson, H. A. (Ed.) *Conf. on Neuropharmacology, Trans. 2nd Conf., Princeton, N. J., 1955*
4. Abramson, H. A. (Ed.) *Conf. on Neuropharmacology, Trans. 3rd Conf., Princeton, N. J., 1956*
5. Abramson, H. A., Jarvik, M. E., Hirsch, M. W., and Ewald, A. T. Lysergic acid diethylamide (LSD-25): V. Effects on spatial relations abilities. *J. Psychol.*, **39**, 435-42 (1955)
6. Abramson, H. A., Jarvik, M. E., and Hirsch, M. W. Lysergic acid diethylamide (LSD-25). VII. Effect upon two measures of motor performance. *J. Psychol.*, **39**, 455-64 (1955)
7. Abramson, H. A., Waxenburg, S. E., Levine, A., Kaufman, M. R., and Kornetsky, C. Lysergic acid diethylamine (LSD-25). XIII. Effects on Bender-Gestalt Test performance. *J. Psychol.*, **40**, 341-49 (1955)
8. Beecher, H. K. Experimental pharmacology and the measurement of the subjective response. *Science*, **116**, 157-62 (1952)
9. Beecher, H. K. Appraisal of drugs intended to alter subjective responses, symptoms. *J. Am. Med. Assoc.*, **158**, 399-401 (1955)
10. Benjamin, F. B., Ikai, K., and Clare, H. E. Effect of prochlorperazine on psychologic, psychomotor and muscular performance. *U. S. Armed Forces Med. J.*, **8**, 1433-40 (1957)
11. Berger, F. M. Spinal cord depressant drugs. *J. Pharmacol. Exptl. Therap.*, **96**, 243-78 (1949)
12. Berger, F. M. The pharmacological properties of 2-methyl-2-n-propyl-1, 3-propanediol dicarbamate (Miltown), a new interneuronal blocking agent. *J. Pharmacol. Exptl. Therap.*, **112**, 413-23 (1954)
13. Berger, F. M. (Ed.) Meprobamate and other agents used in mental disturbances. *Ann. N. Y. Acad. Sci.*, **67**, 671-894 (1957)
14. Braceland, F. J. (Ed.) *The Effect of Pharmacologic Agents on the Nervous System* (The Williams & Wilkins Company, Baltimore, Md., 1959)
15. Brengelmann, J. C. D-amphetamine and amytal: I. Effects on memory and expressive movement. *J. Mental Sci.*, **104**, 153-59 (1958)
16. Brengelmann, J. C. D-amphetamine and amytal: II. Effects on certainty and adequacy of certainty in recall and recognition. *J. Mental Sci.*, **104**, 160-166 (1958)
17. Burch, N. R., and Greiner, T. H. Drugs and human fatigue: GSR parameters. *J. Psychol.*, **45**, 3-10 (1958)
18. Caldwell, A. E. *Psychopharmaca: A Bibliography of Psychopharmacology, 1952-1957, Publ. No. 581* (National Library of Medicine, U. S. Public Health Service, Washington, D. C., 258 pp., 1958)
19. Callaway, E., 3rd. A practical application of information theory in psychopharmacology. *Psychiat. Research Repts.*, **9**, 47-51 (1958)
20. Callaway, E., 3rd, and Band, R. I. Some psychopharmacological effects of atropine. Preliminary investigation of broadened attention. *A.M.A. Arch. Neurol. Psychiat.*, **79**, 91-102 (1958)

21. Callaway, E., 3rd, and Dembo, D. Narrowed attention. A psychological phenomenon that accompanies a certain physiological change. *A.M.A. Arch. Neurol. Psychiat.*, **79**, 74-90 (1958)
22. Cass, L. J., and Frederik, W. S. An experimental and statistical method in the study of new drugs. *A.M.A. Arch. Internal Med.*, **102**, 571-79 (1958)
23. *Chlorpromazine and Mental Health* (Lea & Febiger, Philadelphia, Pa., 200 pp., 1955)
24. Clark, L. D., and Beecher, H. K. Psychopharmacological studies on suppression. *J. Nervous Mental Disease*, **125**, 316-21 (1957)
25. Cole, J. O. Research problems in clinical psychopharmacology. In *Biological Psychiatry*, 212-23 (Masserman, J. H., Ed., Grune & Stratton, Inc., New York, N. Y., 1959)
26. Cole, J. O. Behavioral toxicity (Unpublished data, 1959)
27. Cole, J. O., and Gerard, R. W. (Eds.) *Psychopharmacology: Problems in Evaluation* (National Research Council, National Academy of Sciences, Washington, D. C., 662 pp., 1959)
28. Cole, J. O., Ross, S., and Bouthilet, L. Recommendations for reporting studies of psychiatric drugs. *Public Health Repts. (U. S.)* **72**, 638-45 (1957)
29. Darrow, C. W. Psychological effects of drugs. *Psychol. Bull.*, **26**, 527-45 (1929)
30. Daston, P. G. Effects of two phenothiazine drugs in concentrative attention span of chronic schizophrenics. *J. Clin. Psychol.*, **15**, 106-9 (1959)
31. Delay, J., Deniker, P., and Harl, J. M. Utilisation en thérapeutique psychiatrique d'une phénothiazine d'action centrale élective (4560 RP). *Ann. med. psychol.*, **110**, 112-7 (1952)
32. Dews, P. B. (Ed.). Techniques for the study of behavioral effects of drugs. *Ann. N. Y. Acad. Sci.*, **65**, 247-356 (1956)
33. Dews, P. B. Effect of *d*-amphetamine on an item of operant behavior in humans (Presented at meeting, Am. Soc. Pharmacol. Exptl. Therapeutics, Inc., Baltimore, Md., September, 1957)
34. DiMascio, A., and Klerman, G. L. Experimental human psychopharmacology: The role of non-drug factors (Unpublished data)
35. DiMascio, A., Klerman, G. L., Rinkel, M., Greenblatt, M., and Brown, J. Psycho-physiologic evaluation of phenyltoxicamine, a new phrenotropic agent. A comparative study with reserpine and placebo. *Am. J. Psychiat.*, **115**, 301-317 (1958)
36. Doering, C. R., Hagans, J. A., Ashley, F. W., Clark, M. L., and Wolf, S. Sequential analysis in therapeutic research. I. Application to binomial data and to measured data normally distributed (one-sided alternative). *J. Lab. Clin. Med.*, **50**, 621-28 (1957)
37. Ewing, J. H., Rickels, K., Werntz, J. L., and Lakke, J. P. Research trends in human psychopharmacology. *J. Med. Soc. New Jersey*, **54**, 573-77 (1957)
38. Eysenck, H. J. Drugs and personality. I. Theory and methodology. *J. Mental Sci.*, **103**, 119-31 (1957)
39. Eysenck, H. J., and Aiba, S. Drugs and personality. V. The effects of stimulant and depressant drugs on the suppression of the primary visual stimulus. *J. Mental Sci.*, **103**, 661-65 (1957)
40. Eysenck, H. J., Casey, S., and Trouton, D. S. Drugs and personality. II. The effect of stimulant and depressant drugs on continuous work. *J. Mental Sci.*, **103**, 645-49 (1957)
41. Eysenck, H. J., Holland, H., and Trouton, D. S. Drugs and personality. III. The

- effects of stimulant and depressant drugs on visual after-images. *J. Mental Sci.*, **103**, 650-55 (1957)
42. Eysenck, H. J., Holland, H., and Trouton, D. S. Drugs and personality. IV. The effects of stimulant and depressant drugs on the rate of fluctuation of a reversible perspective figure. *J. Mental Sci.*, **103**, 656-60 (1957)
43. Faurbye, A. Principles for experimental pharmacotherapy. In *Psychopharmacology Frontiers*, 245-50 (Kline, N. S., Ed., Little, Brown & Co., Boston, Mass., 1959)
44. Fisher, S. *Child Research in Psychopharmacology* (Charles C Thomas, Publisher, Springfield, Ill., in press)
45. Fleeson, W., Glueck, B., Jr., Heistad, G., King, J. E., Lykken, D., Meehl, P., and Mena, A. The ataraxic effect of two phenothiazine drugs on an outpatient population. *Univ. Minn. Med. Bull.*, **29**, 274-286 (1958)
46. Foulds, G. A. Clinical research in psychiatry. *J. Mental Sci.*, **104**, 259-65 (1958)
47. Funkenhaeuser, M. Time estimation as affected by barbiturate and metamphetamine. *Rept. Psychol. Lab. Univ. Stockholm*, No. 62, 2-9 (University of Stockholm, Stockholm, Sweden, 1958)
48. Funkenhaeuser, M. Estimation of time as affected by quinine and caffeine. *Rept. Psychol. Lab. Univ. Stockholm*, No. 64, 1-8 (University of Stockholm, Stockholm, Sweden, 1958)
49. Garattini, S., and Ghetti, V. (Eds.) *Psychotropic Drugs* (Elsevier Publishing Co., Amsterdam, Netherlands, 606 pp., 1957)
50. Goldman, D. The results of treatment of psychotic states with newer phenothiazine compounds effective in small doses. *Am. J. Med. Sci.*, **235**, 66-77 (1958)
51. Goodman, L. S., and Gilman, A. *The Pharmacological Basis of Therapeutics* (The Macmillan Co., New York, N. Y., 1800 pp., 1955)
52. Gordon, H. L. (Ed.) *The New Chemotherapy in Mental Illness* (Philosophical Library, Inc., New York, N. Y., 762 pp., 1958)
53. Gottlieb, J. S., Kline, N. S., Lhamon, W. T., Moll, A. E., Himwich, H. E., and Saslow, G. (Eds.) Pharmacologic products recently introduced in the treatment of psychiatric disorders. *Psychiat. Research Repts.*, No. 1 (1955)
54. Gottlieb, J. S., Cleghorn, R. A., Himwich, H. E., Kline, N. S., Lhamon, W. T., and Saslow, G. (Eds.) An evaluation of the newer psychopharmacologic agents and their role in current psychiatric practice. *Psychiat. Research Repts.*, No. 4 (1956)
55. Gottschalk, L. A., Kapp, F. T., Ross, W. D., Kaplan, S. M., Silver, H., MacLeod, J. A., Kahn, J. B., Jr., Van Maanen, E., and Acheson, G. H. Explorations in testing drugs affecting physical and mental activity. *J. Am. Med. Assoc.*, **161**, 1054-58 (1956)
56. Grebe, R. M. (Ed.) *Handbook of Toxicology*, **4**, *Tranquilizers* (Wright-Patterson Air Force Base, Dayton, Ohio, 120 pp., 1959)
57. Hagans, J. A., Doering, C. R., Clark, M. L., Schneider, E. M., and Wolf, S. Sequential analysis in therapeutic research. II. Application to measured data normally distributed (two-sided alternative). *J. Lab. Clin. Med.*, **50**, 629-38 (1957)
58. Harway, V. T., Lanzetta, J. T., Nowlis, H. H., Nowlis, V., Riesen, A. H., and Wendt, G. R. Chemical influences on behavior. *Tech. Rept.* (Office of Naval Research, Contract N6ori-126, Rochester, N. Y., 1953)
59. Hauty, G. T. Methods for the mitigation of work decrement. *U. S. Air Force*

- School Aviation Med., Project 21-1601-0004, Rept. No. 4* (Randolph Field, San Antonio, Texas, 14 pp., 1953)
60. Hauty, G. T. The effects of drugs upon the components of hand steadiness. *U. S. Air Force School Aviation Med., Proj. 21-1601-0004* (Randolph Field, San Antonio, Texas, 8 pp., 1954)
 61. Hauty, G. T., and Payne, R. B. The effects of Dexedrine and Benadrylhyoscine upon judgement. *U. S. Air Force School Aviation Med. Rept. No. 55-104* (Randolph Air Force Base, San Antonio, Texas, 11 pp., 1955)
 62. Hauty, G. T., Payne, R. B., and Bauer, R. O. Effects of normal air and dextro-amphetamine upon work decrement induced by oxygen impoverishment and fatigue. *U. S. Air Force School Aviation Med. Rept. No. 56-125* (Randolph Air Force Base, San Antonio, Texas, 6 pp., 1956)
 63. Hauty, G. T., Payne, R. B., and Bauer, R. O. Effects of oxygen and dextro-amphetamine upon work decrement. *U. S. Air Force School of Aviation Med. Rept. No. 56-127* (Randolph Air Force Base, San Antonio, Texas, 1957)
 64. Heilizer, F. The effects of chlorpromazine upon psychomotor and psychiatric behavior of chronic schizophrenic patients. *J. Nervous Mental Disease*, **128**, 358-64 (1959)
 65. Heilizer, F. An annotated bibliography on the effects of chlorpromazine upon psychologic and psychiatric behavior. (Unpublished data, 1959)
 66. Hess, G., and Jacobsen, E. The effect of benactyzine on the electroencephalogram in man. *Acta Pharmacol. Toxicol.*, **13**, 125-34 (1957)
 67. Hess, G., and Jacobsen, E. The influence of benactyzine on reaction time. *Acta Pharmacol. Toxicol.*, **13**, 135-41 (1957)
 68. Himwich, Harold E. (Ed.) *Tranquilizing Drugs* (American Association for the Advancement of Science, Washington, D. C., 197 pp., 1957)
 69. Holliday, A. R., Duffy, M., and Dille, J. The effects of meprobamate, chlorpromazine, pentobarbital, and a placebo on a behavioral task performed under stress conditions (Presented at Meeting, Am. Soc. Pharmacol. Exptl. Therapeutics, Inc., Baltimore, Md., 1957)
 70. Hollingworth, H. L. The influence of caffeine on mental and motor efficiency. *Arch. Psychol.*, No. 22, 3 (1912)
 71. Jarvik, M. E., Abramson, H. A., and Hirsch, M. W. Lysergic acid diethylamide (LSD-25). IV. Effects upon attention and concentration. *J. Psychol.*, **39**, 373-83 (1955)
 72. Jarvik, M. E., Abramson, H. A., Hirsch, M. W., and Ewald, A. T. Lysergic acid diethylamide (LSD-25). VIII. Effect on arithmetic test performance. *J. Psychol.*, **39**, 465-73 (1955)
 73. Kahn, R. L., and Fink, M. Changes in language during electroshock therapy. In *Psychopathology of Communication*, 126-39 (Hoch, P. H., and Zubin, J., Eds., Grune & Stratton, Inc., New York, N. Y., 1958)
 74. Kelly, E. L., Miller, J. G., Marquis, D. G., Gerard, R. W., and Uhr, L. Continued meprobamate and prochlorperazine administration and behavior. *A.M.A. Arch. Neurol. Psychiat.*, **80**, 247-52 (1958)
 75. Kety, S. S. (Ed.) The pharmacology of psychotomimetic and psychotherapeutic drugs. *Ann. N. Y. Acad. Sci.*, **66**, 417-840 (1957)
 76. Klerman, G. L., DiMascio, A., Greenblatt, M., and Rinkel, M. The influence of specific personality patterns on the reactions to phrenotropic agents. In *Biological Psychiatry*, 224-38 (Masserman, J., Ed., Grune & Stratton, Inc., New York, N. Y., 1959)

77. Kline, N. S. Use of *Rauwolfia serpentina* benth in neuropsychiatric conditions. *Ann. N. Y. Acad. Sci.*, **59**, 107-32 (1954)
78. Kline, N. S. (Ed.). *Psychopharmacology* (American Association for the Advancement of Science, Washington, D. C., 165 pp., 1956)
79. Kline, N. S. (Ed.). *Psychopharmacology Frontiers* (Little, Brown & Co., Boston, Mass., 533 pp., 1959)
80. Kline, N. S., Cleghorn, R. A., Greenblatt, M., Himwich, H. E., Lhamon, W. T., and Pasamanick, B. Research in psychiatry with special reference to drug therapy. *Psychiat. Research Repts.*, No. 9 (1958)
81. Kornetsky, C. Effects of meprobamate, phenobarbital and *dextro*-amphetamine on reaction time and learning in man. *J. Pharm. Exptl. Therap.*, **123**, 216-19 (1958)
82. Kornetsky, C., and Humphries, O. Psychological effects of centrally acting drugs in man. Effects of chlorpromazine and secobarbital on visual and motor behavior. *J. Mental Sci.*, **104**, 1093-99 (1958)
83. Kornetsky, C., Humphries, O., and Evarts, E. V. Comparison of psychological effects of certain centrally acting drugs in man. *A.M.A. Arch. Neurol. Psychiat.*, **77**, 318-24 (1957)
84. Krantz, J. C., Jr., and Carr, C. J. *The Pharmacologic Principles of Medical Practice* (The Williams & Wilkins Co., Baltimore, Md., 1313 pp., 1958)
85. Kubie, L. S. The investigation of the pharmacology of psychological processes: Some methodological considerations from the point of view of clinical psychoanalysis. In *Psychopharmacology*, 302-15 (Pennes, H. H., Ed., Paul B. Hoeber, Inc., New York, N. Y., 1958)
86. Laties, V., and Weiss, B. A critical review of the efficacy of meprobamate (Miltown, Equanil) in the treatment of anxiety. *J. Chronic Diseases*, **7**, 500-19 (1958)
87. Laborit, H., Huguenard, P., and Alluaume, R. Un nouveau stabilisateur végétatif (le 4560 RP). *Presse méd.*, **60**, 206-8 (1952)
88. Lasagna, L., and Meier, P. Clinical evaluation of drugs. *Ann. Rev. Med.*, **9**, 347-54 (Rytand, D. A., and Creger, W. P., Eds., Annual Reviews, Inc., Palo Alto, Calif., 530 pp., 1958)
89. Lehmann, H. E., and Czank, J. Differential screening of phrenotropic agents in man: psychophysiologic test data. *J. Clin. Exptl. Psychopathol. & Quart. Rev. Psychiat. Neurol.*, **18**, 222-35 (1957)
90. Leveton, A. F. The evaluation and testing of psychopharmaceutic drugs. *Am. J. Psychiat.*, **115**, 232-238 (1958)
91. Levine, A., Abramson, H. A., Kaufman, M. R., and Markham, S. Lysergic and diethylamide (LSD-25). XVI. The effect on intellectual functioning as measured by the Wechsler-Bellevue Intelligence Scale. *J. Psychol.*, **40**, 385-95 (1955)
92. Liebert, R. S., Wapner, S., and Werner, H. Studies in the effects of lysergic acid diethylamide (LSD-25). Visual perception of verticality in schizophrenic and normal adults. *A.M.A. Arch. Neurol. Psychiat.*, **77**, 193-201 (1957)
93. Liebert, R. S., Wapner, S., and Werner, H. Studies in the effects of lysergic acid diethylamide (LSD-25). Self- and object-size perception in schizophrenic and normal adults. *A.M.A. Arch. Neurol. Psychiat.*, **79**, 580-84 (1958)
94. Loomis, T. A., and West, T. C. Comparative sedative effects of a barbiturate and some tranquilizer drugs on normal subjects. *J. Pharmacol. Exptl. Therap.*, **122**, 525-31 (1958)

95. Luby, E. D., Cohen, B. D., Rosenbaum, G., Gottlieb, J. S., and Kelley, R. Study of a new schizophrenomimetic drug—Sernyl. *A.M.A. Arch. Neurol. Psychiat.*, **81**, 363-69 (1959)
96. Marquis, D. G., Kelly, E. L., Muller, J. G., Gerard, R. W., and Rapaport, A. Experimental studies of behavioral effects of meprobamate on normal subjects. *Ann. N. Y. Acad. Sci.*, **67**, 701-10 (1957)
97. Meyer, M. The psychological effects of drugs. *Psychol. Bull.*, **19**, 173-82 (1922)
98. Mirsky, A. F., Primac, D. W., and Bates, R. The effects of chlorpromazine and secobarbital on the CPT. *J. Nervous Mental Disease*, **128**, 12-17 (1959)
99. Moran, L. J., and Mefferd, R. B., Jr. Repetitive psychometric measures. *Psychol. Repts.* (In press, 1959)
100. Nash, H. The design and conduct of experiments on the psychological effects of drugs. *J. Nervous Mental Disease*, **128**, 129-47 (1959)
101. Nowlis, V., and Nowlis, H. H. The description and analysis of mood. *Ann. N. Y. Acad. Sci.*, **65**, 345-55 (1956)
102. Payne, R. B. An extension of Hullian theory to response decrements resulting from drugs. *J. Exptl. Psychol.*, **55**, 342-46 (1958)
103. Perlin, S., Pollin, W., and Butler, R. N. The experimental subject: I. The psychiatric evaluation and selection of a volunteer population. *A.M.A. Arch. Neurol. Psychiat.*, **80**, 65-70 (1958)
104. Poffenberger, A. T. Drugs. *Psychol. Bull.*, **11**, 418-21 (1914); **13**, 434-36 (1916); **14**, 408-11 (1917); **16**, 291-98 (1919)
105. Pollin, W., and Perlin, S. Psychiatric evaluation of "normal control" volunteers. *Am. J. Psychiat.*, **115**, 129-33 (1958)
106. Porteus, S. D. Maze test reactions after chlorpromazine. *J. Consulting Psychol.*, **21**, 15-21 (1957)
107. Porteus, S. D., and Barclay, J. E. A further note on chlorpromazine: maze reactions. *J. Consulting Psychol.*, **21**, 297-99 (1957)
108. Rashkis, H. A., and Smarr, E. R. A method for the control and evaluation of sociopsychological factors in pharmacological research. *Psychiat. Research Repts.*, **9**, 121-30 (1958)
109. Reitan, R. M. The comparative effects of placebo, Ultram, and meprobamate on psychologic test performance. *Antibiotic Med. & Clin. Therapy*, **4**, 158-64 (1957)
110. Robinson, E. S. Mental work. *Psychol. Bull.*, **18**, 456-82 (1921)
111. Rothman, T., and Sward, K. Pharmacologic psychotherapy. Verbal communication in psychoanalysis and psychotherapy. In *Psychopathology of Communication*, 177-209 (Hoch, P. H., and Zubin, J., Eds, Grune & Stratton, Inc., New York, N. Y., 1958)
112. Rubin, L. S. The psychopharmacology of lysergic acid diethylamide (LSD-25). *Psychol. Bull.*, **54**, 479-89 (1957)
113. Sainz, A., Bigelow, N., and Barwise, C. On a methodology for the clinical evaluation of phrenopraxic drugs. *Psychiat. Quart.*, **31**, 10-16 (1957)
114. Sainz, A., Bigelow, N., and Barwise, C. Rapid screening of phrenopraxic drugs. *Psychiat. Quart.*, **32**, 273-80 (1958)
115. Schneider, R. A., and Costiloe, J. P. Effect of centrally active drugs on conditioning in man: the inhibiting effects of chlorpromazine, amobarbital, and methylphenidylacetate on the conditioned galvanic skin response. *Am. J. Med. Sci.*, **233**, 418-23 (1957)

116. Shock, N. W. Some psychophysiological relations. *Psychol. Bull.*, **36**, 447-76 (1939)
117. Smith, K. V., Harris, S., and Shideman, F. E. Effects of ethyl alcohol on the component movements of human motions. *Federation Proc.*, **16**, 336 (1957)
118. Steinberg, H. Selective effects of an anesthetic drug on cognitive behavior. *Quart. J. Exptl. Psychol.*, **6**, 170-80 (1954)
119. Stellar, E. Physiological psychology. *Ann. Rev. Psychol.*, **8**, 415-36 (Farnsworth, P. R., and McNemar, Q., Eds., Annual Reviews, Inc., Palo Alto, Calif., 502 pp., 1957)
120. Stoll, A., and Hoffman, A. Partialsynthese von Alkaloiden vom Typus des Ergobasins (6. Mitteilung über Mutterkornalkaloide) [partial synthesis of alkaloids of the ergometrine type (6th communication on ergot alkaloids)]. *Helv. Chim. Acta*, **26**, 944 (1943)
121. Stoll, W. A. Lysergsaure-diethylamid, ein Phantastikum aus der Mutterkorngruppe (LSD, a hallucinatory agent from the ergot group). *Schweiz. Arch. Neurol. Psychiat.*, **60**, (1947)
122. Symposium on the biochemical and clinical aspects of Marsilid and other monoamine-oxidase inhibitors. *J. Clin. Exptl. Psychopathol. & Quart. Rev. Psychiat. Neurol.*, Special Suppl. to **19**, No. 2, 186 pp. (1958)
123. Tourlentes, T. T., Hunsicker, A. L., and Hurd, D. E. Chlorpromazine and communication processes. *A.M.A. Arch. Neurol. Psychiat.*, **79**, 468-73 (1958)
124. Trumbull, R., and Maag, C. H. *An Annotated Bibliography and Critical Review of Drugs and Performance, Rept. ACR-29* (Office of Naval Research, Washington, D. C., 84 pp., 1958)
125. Turner, W. J., Carl, A., Merlis, S., and Wilcoxon, F. Chemotherapeutic trials in psychosis. II. Design and conduct of a trial of raunormine versus reserpine and phenobarbital in chronic schizophrenia. *A.M.A. Arch. Neurol. Psychiat.*, **79**, 597-602 (1958)
126. Tuteur, W. The "double blind" method: its pitfalls and fallacies. *Am. J. Psychiat.*, **114**, 921-22 (1958)
127. Welsh, A. L., *Psychotherapeutic Drugs* (Charles C Thomas, Publisher, Springfield, Ill., 139 pp., 1958)
128. Whitehead, W. A., and Thune, L. E. The effects of chlorpromazine on learning in chronic psychotics. *J. Consulting Psychol.*, **22**, 379-83 (1958)
129. Wikler, A. *The Relation of Psychiatry to Pharmacology* (The Williams & Wilkins Co., Baltimore, Md., 322 pp., 1957)
130. Wikler, A. Methodology of research in psychological pharmacodynamics. In *Progress in Psychotherapy*, **3**, 212-18 (Masserman, J. H., and Moreno, J. E., Eds., Grune & Stratton, Inc., New York, N. Y., 1958)
131. Wilkins, R. W., and Judson, W. E. The use of *Rauwolfia serpentina* in hypertensive patients. *New Engl. J. Med.*, **248**, 48-53 (1953)
132. Wittenborn, J. R., and Kline, N. S. The use of emergent behavior in psychiatric research. *Psychiat. Research Repts.*, **9**, 133-38 (1958)
133. Yonkman, F. F. (Ed.) Reserpine (Serpasil) and other alkaloids of *Rauwolfia serpentina*: chemistry, pharmacology, and clinical applications. *Ann. N. Y. Acad. Sci.*, **59**, 1-140 (1954)
134. Yonkman, F. F. (Ed.) Reserpine in the treatment of neuropsychiatric, neurological, and related clinical problems. *Ann. N. Y. Acad. Sci.*, **61**, 1-280 (1955)

DEVELOPMENTAL PSYCHOLOGY¹

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The past year's literature in developmental psychology consisted of a vast array of new findings about growth and development and the factors affecting these, some reaffirmations of old conclusions, and a scattering of novel ideas. There has been little evidence of progress toward systematic organization of the field. A number of stimulating theoretical contributions appeared, but these dealt with specific aspects of development—e.g., identification, the genesis of communication—rather than with the overall developmental process.

Empirical studies, the sources of the new facts, stem from diverse scientific disciplines and theoretical points of view: psychoanalysis, field theory, learning, role theory, self-psychology; sociological and anthropological analyses and investigations; and physiological theory and research. A substantial part of the relevant research was conducted by investigators who are not developmental psychologists by training or profession.

The study of the socialization process, particularly of parent-child relationships and their effects on children's personality and behavior, has appealed to researchers with different scientific backgrounds and theoretical persuasions. The first section of this review will therefore be concerned with this area of research, in which parent-child interactions are regarded as antecedents and children's characteristics as consequents.

After the first section, there will be a discussion of studies of other conditions (e.g., social class, physique) related to socialization, personality development, and change. The relationships between established personality characteristics, such as dependence and aggression, and other aspects of development will be considered next. The remaining sections will summarize experiments on situational variables as determinants of children's behavior, as well as investigations of social, intellectual, cognitive, and physical development. In general, studies have been grouped together under the classifications to which they are conventionally assigned in texts and courses in developmental psychology.

Progress in any scientific field depends in part on continuous invention and continuous evaluation of research methods. Descriptions of new research instruments and critiques of existing techniques are reviewed, as are theoretical contributions, in the contexts of the substantive areas to which they are most pertinent.

¹ The literature surveyed covers the period from April, 1958, to April, 1959.

SOCIALIZATION

PARENT-CHILD RELATIONSHIPS AND THEIR CONSEQUENCES

In investigations of variations in parent-child relationships and their effects, social and ethical considerations generally preclude the use of experimental methods, i.e., manipulations of independent variables by the experimenter. Antecedent-consequent relationships are typically investigated by means of correlations—e.g., between parental treatment variables (such as maternal authority) and children's personality characteristics—or by comparisons of known groups—e.g., comparisons between children raised in broken homes and those raised in intact homes.

An experimental approach: Harlow's work.—One outstanding experimental approach to the problem of parent-child relations was described in Harlow's fascinating and sprightly presidential address to the American Psychological Association (71). In Harlow's ingenious experiments, young monkeys, separated from their own mothers, were "nursed" by different kinds of surrogate mothers. The first, "made from a block of wood, covered with sponge rubber and sheathed in tan terrycloth . . . was a mother soft, warm, and tender, a mother with infinite patience, a mother available 24 hours a day, a mother that never scolded her infant and never struck it or bit her baby in anger." The second mother was made of wire mesh and differed from the cloth mother surrogate only in being unable to supply "contact comfort." When allowed to contact either "mother" as frequently and for as long as they desired, the infants showed decreasing responsiveness to the lactating wire mother and increasing responsiveness to the nonlactating cloth mother. If frightened or in a strange situation, the monkeys consistently rushed to the cloth mother, clutching her, and rubbing against her. "The affectional bond is highly resistant to forgetting and . . . can be retained for very long periods of time by relatively infrequent contact reinforcement." These findings on the overwhelming importance of "contact comfort" seem to support some of the conclusions of Ribble and others about the importance of physical contact with the mother (71). The primary significance of the work, however, is the tremendous research potential of these experimental techniques. The field of developmental psychology will undoubtedly be considerably enriched by animal experimentation of this type.

Methods of assessing parental attitudes.—In contrast to Harlow's uncomplicated "mothers," human parents vary widely in behavior, personality, and attitudes, and the adequate assessment of these variables is crucial to the study of the relationships between parental and child behaviors. This assessment is generally accomplished by means of observations, interviews, or questionnaires.

Levy has presented a highly detailed account of his observational method of assessing maternal attitudes toward newborn infants (109). Basically, the method consists of an accumulation of ordinary observations of the mother's reactions to, and interactions with, her baby from the moment the nurse

arrives till she takes the baby away. The observational units each represent a distinct maternal response. The method is distinctive in its extraordinary attention to the minutiae of maternal behavior, and may have a great deal of research potential; but the tremendous labor required will probably discourage its widespread use.

Interviews with mothers and observations of them interacting with their children are equally good methods for procuring valid measures of maternal behavior, according to Smith's data (161). Observed behavior was generally consistent from one part of the observational period to the next, and most mothers reported behavior similar to that observed. The interview may be the preferable method, however, because it permits sampling a wider range of behavior in a shorter period of time.

The general use of various questionnaires in research on parental behavior raises questions about their comparability and validity. Apparently, Shoben's Parent Attitude Survey and a revision of the Minnesota Teacher Attitude Inventory do not measure the same attributes: the two were uncorrelated in a sample of parents of grammar school children, and neither of them differentiated between the parents of well-adjusted and poorly-adjusted children (104).

Bell's outstanding critical paper (11) presents a thorough consideration of the methodological problems of parental attitude questionnaires, particularly of the retrospective kind, together with thoughtful suggestions for coping with some of these problems. Examples of his suggestions are the use of appropriate item phrasing, presentation of statements in opposition to current theories, and provision of rationalizations for some opinions. These suggestions were incorporated into the Parental Attitude Research Instrument (PARI), which consists of 23 five-item scales, each empirically homogeneous and measuring a specific attitude concept such as equalitarianism, suppression of aggression, or strictness. Internal consistency and test-retest reliabilities are satisfactory, but no validity data are reported (153). The extremely careful design of the scale, reflected in its comprehensiveness, efficiency, and objectivity, makes it the most adequate parental attitude questionnaire available for research. PARI norms based on extensive and representative samples have been published and the intercorrelations among the scales have been factor-analyzed. Three factors were extracted: authoritarian-control, hostility-rejection, and democratic attitude toward child rearing (200).

For some purposes, it may be important to evaluate parental behavior and attitudes from the child's point of view rather than from that of the parents or an observer. Williams' PALS (parental authority-love statements) tests (190) consist of a projective test and a rating scale which measure the child's perception of both parents as sources of need fulfillment, authority, and love. The test seems promising. There is some evidence of its validity, but further data are needed before it can be used confidently in either research or diagnosis.

Among tenth-grade boys, intrafamilial attitude scores, based on objective analysis of Thematic Apperception Test (TAT) responses, were found to be significantly related to comparable attitude scores derived from direct and indirect questionnaires and interview techniques. Any of these techniques may be useful in evaluating parent-child relationships from the child's point of view (30).

CORRELATES OF PARENTAL ATTITUDES

Cultural variables.—The parents' child-rearing behavior and attitudes are determined by many social, economic, and personal background factors. In a most stimulating book, *The Changing American Parent*, Miller & Swanson (122) examined the distinctive child-training patterns of "entrepreneurial" and "bureaucratic" parents. Entrepreneurial parents are employed in "organizations having these features: small size, a simple division of labor, a relatively small capitalization, and provision for mobility and income through risk-taking and competition" (page 57). The bureaucratic parents, on the other hand, work in large organizations with many different kinds of specialists; mobility depends on specialized training rather than on taking risks. The two kinds of organizations represent different "integration settings," affecting the individual's total life pattern, including his child-rearing practices. Entrepreneurial parents accentuate training for self-control and self-denial, and for active and independent behavior. By contrast, bureaucratic parents foster passivity and dependency, encouraging their children to allow their impulses some spontaneous expression (see page 58).

Analysis of interview data, collected as part of the Detroit Area Study, confirmed the prediction that middle-class entrepreneurial mothers employ more "internalization techniques" and emphasize an active, manipulative approach to life, self-control, and responsible independence more than bureaucratic mothers of the same class do. Class differences within each "integration setting" were not nearly as great as differences between the two primary groupings (122).

These findings represent only a sampling of the extensive data presented in this thoughtful and challenging book. While some methodological questions are left unanswered and data from parents in other sections of the country are needed to establish the general validity of the findings, the work is an outstanding contribution to the literature on parent-child relations. Its distinction stems from its unique integration of a developmental psychological orientation, sociological analysis, and social survey techniques, and its systematic linking of child-rearing practices and the parents' "way of life."

Other broad cultural and subcultural variations also influence the choice of child-rearing practices. In comparison with Italian-American parents, Jewish parents have higher educational and occupational expectations for their sons and, in general, maintain and transmit values that are more likely to promote high achievement (119). In the Soviet Union, principles of

family life, child rearing, and education stem from established national goals. The most remarkable feature of the Soviet system, from the point of view of personality development, is the consistency in the goals stressed in the family and in other socialization agencies, which continually emphasize ideals such as courage and service to the state rather than individual gain and conformity rather than initiative and enterprise (4).

A cross-cultural study by Barry, Child & Bacon (10) suggests that child-training practices "are shaped by the behavioral requirements of adult economic roles." Societies that have facilities for storing food resources tend to stress responsibility and compliance, whereas societies with low accumulation of food resources emphasize achievement, self-reliance, and independence.

Personal history and characteristics.—Analysis of cumulative case histories on 100 families indicated that there is little direct transfer from parents' retrospective assessments of their own parents to their actual behavior towards their children. However, mothers show a tendency to emulate their own mothers if they perceive them as high in authority, while fathers tend to imitate their own fathers in affection. Mothers and fathers do not differ significantly in affection or involvement, but more mothers than fathers are high in authority (24).

Less well-educated and older mothers tend to show more severe, authoritarian, and suppressive child-rearing attitudes (199). Authoritarianism (F) correlates significantly with the authoritarian-control factor from the PARI, while achievement and aggressive needs correlate positively, and self-acceptance and needs for nurturance and affiliation correlate negatively with the PARI hostility-rejection factor. Apparently, a mother's child-rearing techniques reflect the kind of person she is (198).

Milton (124) factor analyzed the intercorrelations among 44 child-rearing variables. Of the seven independent factors extracted, five were stable and clearly defined: "strictness of parental behavior; general family interaction or adjustment; warmth of the mother-child relationship; responsible child-training orientation; aggressiveness and punitiveness" (124).

EFFECTS OF PARENTAL BEHAVIOR AND ATTITUDES ON CHILD PERSONALITY AND BEHAVIOR

This is a very vigorous area of research, but the diversity of antecedent and consequent variables considered, subjects studied, and techniques employed make it extremely difficult to integrate the findings. The findings are generally consistent, however, in demonstrating that the child's familial experiences are prime determiners of his personality. In contrast to many earlier reports, one team of investigators found that the incidence of gastrointestinal disturbances was at least as high, if not higher, among the infants of less-anxious or better-adjusted mothers, as among the more-anxious or poorly adjusted mothers (137).

In Antonovsky's study (6), mothers of children between 20 and 23 months

of age were interviewed and then observed in interaction with their children for one-half hour. Mothers were rated on a number of variables, while children's behavior was scored for dependency, aggression, and initiative. While the correlations were not generally significant, some important directional tendencies generally consistent with the findings of other studies (158, 168) were discovered. Help-seeking responses, an index of dependency, were negatively related to the degree of maternal affectional contact and positively related to maternal demands, restrictiveness, and punishment. Disobedience, a measure of aggression, was related positively to maternal restrictiveness and negatively to the degree of maternal demands and punishment (6).

High or low parental dominance generates more avoidance of adults among nursery school children than an intermediate amount does (178). Among 6-, 7-, and 8-year old subjects, maternal rewards for compliance were found to be more effective than punishment for noncompliance in fostering social compliance outside the home (36).

Peck's excellent study, based on intensive longitudinal data, is unique in examining the relationships between the general climate of the home and several dimensions of "inner" personality of adolescents (132). Four dimensions of family interaction—consistency, democracy, mutual trust and approval, and parental severity—were correlated with six dimensions of children's personality: ego strength, superego strength, willing social conformity, spontaneity, friendliness, and a hostility-guilt complex. Ego strength was significantly correlated with stable and consistent family life in which there is mutual trust and approval between parents and child. Superego strength was related to ego strength and was associated with the same factors, but was not associated with severely autocratic rearing. Friendliness and spontaneity seem to derive from lenient, democratic family atmospheres, while the hostility-guilt complex is generated by severely autocratic, untrusting, and disapproving, i.e., severe, unloving, and inconsistent, families.

Children's perceptions of their parents' attitudes and behavior—which may or may not be accurate—may also influence the children's behavior. In response to TAT-like pictures of adult-child relations, extremely aggressive boys told more stories of hostile parent-child interactions and manifested relatively less dependence upon parents than did nonaggressive boys (93). According to 70 college women's answers to autobiographical questions about their parents' disciplinary techniques as they retrospectively perceived them, positive types of parental discipline were associated with favorable attitudes toward parents (127). Among children of dominant and over-protective parents, those disciplined by positive methods displaced aggression to persons other than parents more than did those disciplined by negative methods.

Identification.—Much of the child's behavior and many of his personality characteristics are acquired, not as a result of direct "teaching," but as a

consequence of his identification with parents. The process of identification has become the subject of a great deal of theorizing and empirical research. In a tightly reasoned and lucid theoretical paper, Kagan (92) hypothesizes that the salient motive(s) may not be only the reduction of anxiety over anticipated aggression from a model, but also the pleasure of experiencing positive goal states, particularly mastery of the environment and love-nurturance, which the identifier perceives that the model commands. Since identification is essentially a learning process, its strength is a function of the strength of the motives and the quality and frequency of reinforcements. From this, it follows that the strength of identification should decrease with age and increase with amount of direct contact with the model.

Sex typing of behavior is generally regarded as a manifestation of sex-role identification, and, by inference, of identification with the like-sexed parent. Two papers (25, 117) present thoughtful examinations of the development of sex roles, and distinguish between the concept of sex-role identification and two other related concepts, sex-role preference and sex-role adoption. Sex-role preference and adoption refer to the desire to adopt, and the actual adoption of, sex-appropriate behavior, while identification is reserved for a more basic process, the incorporation of the sex-appropriate role and its characteristic unconscious reactions. The predominantly male values of our culture may have a weakening effect on the girl's feminine identification, especially since girls are allowed relatively greater latitude in sex-role learning (25). Lynn hypothesizes that, with increasing age, males become relatively more firmly identified with their appropriate sex role while females become less so; larger proportions of females than of males prefer, and adopt aspects of, the role of the opposite sex; males are more likely to identify with cultural stereotypes of their roles, while females tend to identify with their mothers' roles (117).

A number of empirical studies are directly relevant to some of the theoretical issues discussed in the papers reviewed above. Perceived similarity to the like-sexed parent was Gray's index of identification, which was found to be related to sex-typed behavior, as rated by peers, among eighth-grade children (69). Boys who see themselves as more similar to their fathers show better adjustment than boys who perceive themselves as quite different from their fathers, while girls who see themselves as resembling their mothers do not show better adjustment.

Among Schutz's Harvard student subjects, those who perceived their parents, retrospectively, as high in attention (i.e., the parents included their children in their activities) were high in group participation (according to observers' ratings), while boys whose parents were strict disciplinarians and controllers tended to be highly autocratic in their interpersonal relations (155). Parental warmth and affection were significantly associated with the subject's attitudes toward, and desire for, warm personal relations. These data are particularly interesting because they concern important motivation areas, but it is difficult to differentiate which variables are the antecedents

and which are consequents; hence, it is difficult to evaluate their bearing on the process of identification.

Effects of separation from home and "intermittent" mothering.—Schaffer observed the reactions of 76 infants in the first year of life after they returned to their homes following a period of hospitalization. Two distinct postseparation syndromes emerged, each closely associated with a particular age range. Children under 7 months manifested a global symptom (extreme preoccupation with the environment, blank and bewildered facial expressions, somatic upsets), while, after 7 months of age, the major syndrome consisted of overdependence on the mother, excessive crying, clinging, and fear of strangers. Since there is little overlap between the syndromes, the author concludes that there is a stepwise, rather than a gradual, development of mother-child relationship and reactions to separation (154). Separation from the mother during early childhood, and concomitant depression, may be important factors in the etiology of leukemia (70).

In contrast to the usual family experiences in western society, children in Israeli *kibbutzim* (collective settlements) live in children's homes from birth on, even though they have strong emotional ties to their biological parents and see them daily. From the second year, the child is mainly cared for by a *metapalet* (nurse) who takes charge of four to six children, fulfilling a combination of mother and nursery-school teacher roles (144, 193). Obviously, this situation provides a kind of "natural experiment" for testing a number of important hypotheses about personality development, such as the effects of lack of intimate and continuous relations with the mother, and the universality of the Oedipus complex.

Rabin (142) compared *kibbutz* and non-*kibbutz* Israeli village children on a wide variety of tests. While young *kibbutz* infants showed a lower level of ego development, as judged by tests of social and interpersonal responsiveness, 10-year-olds "race ahead of the control group as far as ego and intellectual factors are concerned" (142). Apparently, under some circumstances, lack of consistent warm early relationships with the mother does not have enduring harmful effects. It must be emphasized, however, that the general environment of the *kibbutz* is warm and stimulating, and gradually a continuous, meaningful relationship between the child and his mother crystallizes (144). Judging from the responses to the Blacky Test, 10-year-old *kibbutz* boys manifest less Oedipal intensity and less sibling rivalry than do other boys of the same age (143). Some possible negative consequences of *kibbutz* rearing have also been suggested: compared with control groups, *kibbutz* boys show weaker father identifications (140, 143), more suspiciousness of friends, more guilt, less self-confidence, and less optimism about the future (141).

Parental behavior and children's emotional disturbances.—Another way of discovering the consequents of variations in parental personality, attitudes, and child-rearing techniques is to compare parents of emotionally-disturbed and normal children. Nonprojective tests of personality and attitude have not generally been sensitive enough to differentiate these groups.

For example, the mothers of schizophrenics and controls did not differ in PARI responses indicative of severe discipline, control, or rejection (198), or "possessiveness" (58).

Differences between the parents of normal and disturbed children are more likely to emerge from interviews, projective techniques, or batteries of tests. The mothers of schizophrenic sons manifest significantly more Rorschach signs of pathology and immaturity than do mothers of normal children (192). According to the same test, mothers of children with primary autism show little ability to establish social and emotional relationships, while mothers of children with secondary autism have morbid fantasy lives (13).

Interview data suggest that mothers of emotionally disturbed children are more restrictive, lax, and overindulgent in child-rearing attitudes, while moderately permissive maternal attitudes appear to be associated with normal adjustment in the child (1).

The Q-sort method was used by Block *et al.* (19) to evaluate the Minnesota Multiphasic Personality Inventory and projective test protocols of mothers of matched groups of neurotic and schizophrenic children. The two groups of mothers did not differ significantly on any of the Q-sort items, but results of cluster analysis revealed a cluster of items characteristic of "neurotogenic" mothers (submissive, uncertain, pervaded by guilt and worry, and in constant need of reassurance) and one other typical of "schizophrenogenic" mothers (guileful, distrustful, sarcastic, competitive, hostile, and selfish).

Intensive work with whole family units of schizophrenic patients convinced Wynne *et al.* (195) that schizophrenic breakdowns are the consequence of a total context of "pseudo-mutual" family relationships (intense absorption in meshing the behavior and goals of all members of the family). Psychotic episodes are seen in part as miscarried attempts at individuation.

Only one study dealt systematically with the influence of both parents. Parents of guidance clinic patients were rated on the basis of interviews as less well adjusted and sociable and more autocratic than the parents of a control group of normal children. Fathers of the clinic patients were more prone than the control fathers to make suggestions and to be regarded as either highly-active and rigidly organized or relatively inactive and disorganized. "The most significant finding to emerge from this study is that the attitudes of fathers are at least as intimately related as maternal attitudes to the occurrence and form of behavior problems in children" (136). The conclusions of the study must be interpreted with caution, because the data may be somewhat confounded due to the interviewers' knowledge of the clinical status of the children whose parents were being interviewed.

CULTURAL INFLUENCES ON PERSONALITY DEVELOPMENT

Since, as noted earlier (see page 442), cultural variations may influence child-rearing practices, it may be assumed that such variations also affect personality development. The relationship between culturally-determined

child-rearing practices and the development of personality was the focus of several unsystematic observational studies. For example, child-rearing practices were held to be responsible for: the development of weak affectional ties and a value system in which "safety" and conformity are paramount in a Belgian Congo tribe (96); the precocity of Uganda infants in adaptivity, language, and personal-social relations (61); and the increasing submissiveness and withdrawal in reaction to emotional episodes among Filipino children as they grow older (84). Some of the differences between children raised in Israeli *kibbutzim* and other children noted above (see page 446) may be most parsimoniously interpreted in terms of general *kibbutz* milieu. According to sentence completion tests, *kibbutz* boys, compared with Midwestern American boys of the same age, are more concerned with mature occupational and academic goals, social interrelationships, and events which violate codes and interpersonal taboos; they are more self-critical, more stoic, and less childish (141).

A systematic cross-cultural study revealed that societies with beliefs in aggressive gods and spirits are likely to have relatively rigid, nonpermissive child-rearing practices, while more indulgent treatment tends to be related to cultural belief in benevolent deities. Children's behaviors also appear to be clearly related to the characteristics attributed to the supernatural, those in societies with aggressive gods being characteristically more self-reliant, more independent, and less nurturant than those in societies with benevolent gods (98).

Within our own culture, variables such as social class, race, and religion influence the covert and overt aspects of the child's personality. Among rural and small-town children, those from higher socioeconomic-status families show significantly fewer indications of personality maladjustment on the Rogers' Test than children from lower status do (28, 29). These differences may be explained on the basis of class differences in family stability, consistency, and supportiveness, but such an explanation is tenable only on the assumption that the tests provide equally valid measures of adjustment for children of all classes, i.e., that the test is not class biased. The greater degree of internalization of achievement striving in middle-class, compared with working-class, high-school students was demonstrated in two related experiments (76).

Since racial and religious groups may differ with respect to socialization practices, differences in the personality and behavior of children in these groups might be anticipated. Negro boys and girls reveal greater anxiety on the Children's Manifest Anxiety Scale than do white children of the same age (131). This may be due to a greater degree of underlying anxiety in Negro children or to a bias in the test. According to Lesser's data, Catholic, Protestant, and Jewish boys do not differ significantly from each other in either covert or fantasy aggression, but, in their TAT stories, Catholic boys employed more defensive inhibitions against aggression than the other groups did (103). The results of the study are suggestive, but would be enriched by

data on actual differences in socialization practices in the families of different religious backgrounds.

OTHER VARIABLES INFLUENCING PERSONALITY DEVELOPMENT

Considering the amount of time children spend at school under the guidance and supervision of teachers, the paucity of systematic studies of these obviously powerful socialization agents is astounding. The influence of the teacher's training on his understanding of the pupils and on their adjustment was studied by Perkins (134, 135). According to his data, teachers who participated in a child-study program designed to help them gain deeper understanding of children and those who were somewhat insecure (less accepting of themselves and others) had more insight into their pupils' personalities than other teachers had (135). Children whose teachers have completed a child-study course are more likely than others to change in the direction of better adjustment (measured in terms of congruency between self and ideal self) during the school year (134). The differences may be attributable to the beneficial effects of a child-study course which sensitizes the teacher to the child's needs. It is equally possible, however, that teachers who are interested in personality, and perhaps have more insight at the outset, are more likely to enroll in such courses.

Children's self concepts may be profoundly affected by their teachers' accepting and rejecting statements, and teachers differ widely in the extent to which they use such statements (167). After 12 weeks in an experimental class in which the teacher made frequent ego-building statements to each child, pupils' positive self-ratings increased and "uncertainty" ratings decreased, whereas, in a control class, there was an actual increase in uncertainty scores. The results of these studies are provocative, but, for several reasons, do not readily lend themselves to generalization. The basic problems of the effects of school and teacher on the child's personality can be adequately answered only by more extended investigations, including a broader sampling of both child and teacher behavior and systematic study of the variables of teacher personality.

The child's personality may also be strongly influenced by his physique and health status. Physically accelerated adolescent girls manifest significantly more favorable self-concepts in their TAT responses than do physically retarded adolescent girls (91). Surgency tends to be associated with physical strength, and boys who are highly agile and physically powerful tend to be admired by their peers (27).

The consequences of chronic illnesses, crippling, or both, on personality structure have also been systematically studied. For example, asthmatic and cardiac children were found to be similar in many personality characteristics, but both groups are more maladjusted, anxious, insecure, and dependent than normals, presumably as a result of their chronic illnesses (128). Judging from their responses to projective tests, children who have severe physical handicaps appear to be psychologically healthier and have more vitality,

inner resources, and creativity than children in need of psychiatric help (189). In addition to these studies, there were some excellent clinical papers dealing with the effects of severe and unusual physical disabilities on ego-functioning and the formation of defense mechanisms (15, 56, 177). These studies, which consist largely of case histories and clinical descriptions, lack methodological rigor, but they may be valuable sources of hypotheses about personality development under extremely adverse conditions.

PERSONALITY ORGANIZATION AND FUNCTIONING

Thus far our attention has been directed to studies of personality development and the variables antecedent to the acquisition of specific personality characteristics. Once established, such characteristics affect and control other aspects of behavior, i.e., certain aspects of personality structure—particularly those labelled drives and needs, such as aggression, anxiety, and dependence—may be regarded as antecedent variables. Certain personality dimensions have very broad implications, subsuming many different kinds of overt and covert behavior; others have narrower meaning. Aspects of personality may conflict with one another, generating a variety of behavior reactions. Moreover, since behavior is, in the words of Lewin's generally accepted "formula," a function of personality and environment, situational factors play an important role in the manifestation of personality characteristics. Recent studies, demonstrating the operation of these general principles in many areas of personality, stem from several conceptual frameworks and make use of a wide variety of tests, observations, and experimental techniques. These will be reviewed in this section, following a brief survey of the past year's literature on tests of children's personality.

Personality tests for children.—While one new children's test useful for diagnostic screening was published during the past year (139), most of the literature on personality tests consisted of attempts to check the reliability, validity, and limitations of available instruments. In Smith's study (162), three adjustment groups were significantly differentiated in the California Test of Personality, the Rogers' Test of Personality Adjustment, the Group Conformity Rating of the Rosenzweig P-F study, and an unpublished test, the How-I-Feel-About-Things test. Distributions of scores in the three groups overlapped considerably, however. By and large, the results reported during the past year emphasize the limitations of tests in general use. For example, the dangers of evaluating adolescents' scores on personality inventories in terms of adult norms (184), and of interpreting the California Psychological Inventory (CPI) without taking intelligence and social status into account (112), have been pointed out. There is some evidence that Barron M cards are useful with adolescents (166) and, as Rorschach experts have maintained, Rorschach cards IV and VI tend to elicit "father" associations in children; but there is no evidence that card VII is a "mother" card (110). Kindergarten children's responses to the Children's Apperception Test

(CAT) showed that pictures do not always elicit the kinds of dynamic responses for which they were designed (100). The reliabilities of the Blacky Test (68) and of the Children's Manifest Anxiety Scale (CMAS) (77) have been well established, but the latter instrument may not be appropriate for the assessment of anxiety among high-grade retarded, emotionally disturbed children (147). Research findings challenge the diagnostic validities of several projective tests and "signs" (35, 50, 129, 187).

Lesser (101, 102) presented two salient methodological papers on personality assessment. He demonstrated that fantasy (TAT) aggression responses are scalable according to the Guttman method and do, in fact, express a single dominant drive variable, the strength of which can be assessed by scores on the scale (101). This degree of precision is rare in projective measurements, and the work may serve as a model for subsequent improvements in personality assessment. Lesser's second paper (102) reported that several measures of aggression were highly intercorrelated for groups of children who were low in anxiety about aggression, but that the tests had significantly lower intercorrelations in a group of children high in anxiety. The general significance of the study is its demonstration that a single personality measure may display differential validity for different groups.

Anxiety.—Anxiety as a drive has figured prominently in recent developmental investigations. A group of researchers at Yale, working under Sarason's direction, has produced an integrated series of studies establishing the construct validities of two tests—Test Anxiety Scale for Children (TASC) and the General Anxiety (GA) Scale—and exploring many facets of the interfering effects of anxiety. In these studies, matched groups of highly anxious (HA) and low anxious (LA) children, representing upper and lowest quartiles of anxiety scores, have been compared in projective and academic tests, learning tasks, questionnaires, and classroom observations. On the Rorschach, HA subjects gave more signs of interference and ineffective functioning than LA children did (149). In a semistructured expressive task, human-figure drawing, the HA child's accuracy, spontaneity, and expressiveness were diminished, while the LA child was more likely to draw in an expressive, pleasurable, and unconstricted fashion (57).

In school, HA boys were less adequate academically, showed less task orientation, and manifested greater insecurity in their relationships with teachers than LA boys. HA girls, however, created a more favorable impression than LA girls, showing stronger needs for achievement, less "unintelligible" (dreamy, staring, baffling, puzzling) behavior, and more persistent attention to the tasks at hand (150). LA subjects performed significantly better than a matched group of HA subjects on a paired-associates learning task, suggesting the presence of interfering factors in the HA group and thus giving additional evidence of the validity of the children's scale (182). While HAs did more poorly than LAs on both game-like (Davis-Eells) and test-like (Otis Beta) tests, over a three-year period, LAs gained more on the test-

like test and HAs gained more on the game-like test (114). Subjects high in test anxiety showed more marked tendencies to self- and other-blame than subjects low in anxiety (44).

Extended work on the validation of the two anxiety scales involved cross-cultural study with 160 American and 160 English children in grades 1 to 4. Since school examinations seem to be more important to a child's future in England than in America, increasing in number and importance with increased schooling, the investigators predicted and found a higher level of test anxiety in England than in America and in higher than in lower grades (151). Contrary to predictions, however, the English children's scores on the Test Anxiety Scale for Children did not rise before their very important "eleven plus" examinations, nor were their scores correlated with performance on these tests (152).

Viewed together, this series of studies is outstanding in its breadth and in its integration of observational, clinical, and experimental techniques in clarifying the concept of anxiety and specifying its many effects on behavior. An adequate theory of anxiety will have to incorporate answers to many unanswered questions—for example, the marked cultural and sex differences in the consequences of anxiety. But since the research program is vigorous, intensive, and extensive, and the basic instruments appear to be useful and reasonably valid, explanation of some of the puzzling findings and a more adequate conceptualization of anxiety are probably forthcoming.

A well-designed experiment enabled Smock (163) to study the perceptual consequences of manifest anxiety, using the Children's Manifest Anxiety Scale with fifth graders. Highly anxious subjects manifested higher perceptual rigidity, and there was partial confirmation of the prediction that high levels of anxiety (or high drive levels) lead to shorter latencies on cognitive and perceptual closure tasks (163). High anxiety has also been found to be associated with self-disparaging descriptions on adjective lists (115), and with less accuracy in perception of one's own sociometric status (179).

Aggression.—The sensitivity of children's interpersonal aggressive responses to the social setting was neatly demonstrated in an experiment by Siegel & Kohn (160). Eighteen children were observed in two free-play sessions with a younger friend, nine of the children being observed under conditions of "adult present" and nine with "adult absent." Aggressive responses were recorded and rated. All subjects observed under the adult-absent condition showed less aggression in the second session, while six of the nine subjects observed under the adult-present condition increased in aggression in that session, just as doll-play aggression in the presence of an adult increases from the first to the second session. These investigators maintain that "adult behavior which is intended by the adult to be 'accepting' is seen by the child as permission-giving." When an adult is present the young child may abdicate superego and ego control, whereas, if there is no adult present, the child's own internalized standards are invoked.

Dependency.—Hartup's experimental study of the effects of nurturance

and nurturance-withdrawal is notable for relating personal needs and situational variables to children's dependency behavior (73). The hypothesis, derived from psychoanalytic theory, stated that children who experienced nurturance withdrawal (frustration of dependency needs) would learn simple tasks eliciting adult approval more efficiently than children who had been consistently nurtured by the experimenter. One group of nursery school children was consistently nurtured (smiled at, talked to, etc.) by a female experimenter for 10 minutes, while a matched group was nurtured for five minutes, after which the experimenter withdrew (nurturance withdrawal). After these first sessions, the children were asked to learn two tasks, one involving a simple position concept and the other being to copy a row of colored cubes. Measures of the child's dependency needs were obtained from several observations and ratings. The findings for girls uniformly support the hypothesis, but, among boys, only those high in dependency learned the tasks more efficiently under conditions of nurturance withdrawal. Low dependency boys responded in a way opposite to that predicted by the hypothesis (73). These findings, derived from a well-conceived and carefully executed experiment, increase one's confidence in the conclusions of earlier nonexperimental investigators who have also reported significant relationship between frustration and inconsistent gratification and increased dependency in children (156, 168).

Beller presented evidence, consistent with Hartup's, that dependency behavior is higher in experimental dependency stress situations (less adult availability) than in comparable nonstress situations (12). Moreover, the higher a child's initial dependency, the greater will be the increase in his dependency behavior under stress conditions. The dependency drive often conflicts with the child's autonomy drive, and, when this conflict is high, the child is more inhibited and inconsistent in his expression of dependency responses and gives more evidence of having behavior problems. Highly dependent children with low dependency-autonomy conflict manifest more infantile and unsocialized behavior and are more likely to accept help whenever it is offered to them. Under conditions of stress, various aspects of dependency are more clearly expressed. These are only a few of the impressive results of Beller's study, which has been reported only in very much summarized form. The research procedure is both apposite and fascinating, and the reported results are tantalizing, but proper evaluation will be possible only when a complete account is available.

Achievement and affiliation needs.—From Australia comes a study demonstrating that, among sixth grade boys, experimental arousal of achievement orientation can lead to higher level of aspiration and to more fantasy achievement motivation (in stories told in response to four pictures from McClelland's original series). This finding came from a comparison of the responses of two groups, one working under relaxed "game" conditions, the other under achievement-oriented conditions (54). Analysis of the boys' stories and some findings from the level of aspiration experiment led the investigator to con-

clude that n Achievement scores measure different sets under relaxed and achievement-oriented conditions, "fear of failure" under the relaxed condition and "hope for success" under the achievement-oriented conditions. Some of the findings reinforced results of American studies on the arousal of achievement motivation, and the study elucidates the complexity of what is presumably a single motive.

Focusing their attention on achievement and affiliation needs, Vogel, Raymond & Lazarus (181) experimentally studied the effects of personal motivations on reactions to stress or emotional arousal. Their subjects, 40 late-adolescent boys, were classified on the basis of questionnaires and ratings as primarily affiliation- or achievement-oriented. Half of each group was given an affiliation-stressor condition (threats about ability to be warm and friendly). The other half was given an achievement-stressor condition (threats about intellectual and academic ability). Emotional arousal was measured by means of autonomic reactions, including pulse, blood pressure, and galvanic skin response. The results clearly support the hypothesis that emotional arousal depends on the relationship between the individual's intrinsic needs and type of stress conditions. When the achievement-oriented group was presented with achievement-oriented stress, there was a high degree of emotional arousal, but, when this group was exposed to affiliation-stressor conditions, there was little reaction. There were analogous findings with respect to the affiliation-oriented group.

Pride and shame.—Empirical investigations of these two obviously important, but elusive, attributes are practically nonexistent. Baldwin & Levin attempted to define the concepts operationally and to work with them experimentally (9, 105). In one study, children between 8 and 12 years of age served as subjects in an experimental test of the hypothesis that failure tends to increase speed and decrease accuracy on repetitive motor tasks and that the presence of an audience produces the same effects. The investigators' predictions about the effects of success and failure were confirmed, but, contrary to expectations, the presence of an audience did not intensify these effects (9). The same investigators also tested the hypothesis that "people will want to be more visible after a success than after a failure experience." Furthermore, they predicted that the amount of visibility desired will vary with the prestige status of the audience (105). The first prediction, but not the second, was substantiated in an experiment in which 30 girls experienced both success and failure in building a model. Under these conditions, the children were willing to be more visible after they had performed a task successfully than after they had failed, and they wanted to be most visible if the success had followed a previous failure. In explaining the findings, the authors say, "When children anticipate feelings of pride, they will choose to make themselves and their competencies visible. Conversely, the anticipation of shame disposes them to conceal themselves and their inadequacies" (105).

Self-concept, self-estimate, and ego control.—Several contemporary per-

sonality theories are characterized by an emphasis on the self, self-concept, and the ego and its functions. These theories have been used as core concepts around which many major aspects of personality are organized. Psychologists have only recently begun to turn their research attention to the problems of the development of self-concept and the correlates of different types of self-evaluations.

Brandt (22) measured the accuracy or reality of self-estimates of sixth- and eleventh-grade students by comparing their ratings of their own abilities and social reputations with actual performances in several academic and physical tasks and with classmates' sociometric nominations. Between-individual variation in accuracy of self-estimate was found to be significantly greater than within-individual variation, thus supporting "the idea that the self-concept is an organized and organizing dynamic with personality structure." Accuracy or inaccuracy in self-estimate appears to be a general characteristic of the individual, and at least one-quarter of the subjects either consistently overrated or consistently underrated themselves. Both sexes overrated more than they underrated themselves, but the tendency was significantly more pronounced among boys. Accuracy of self-estimate was found to be positively related to intelligence, to the ability to predict the social status of others, and to acceptance by peers (22).

Data from two Q-sorts taken two years apart show that the self-concepts of adolescents tend to be relatively stable, with a mean shift in the positive direction. Those maintaining negative self-concepts were significantly more maladjusted than were subjects who persisted in a positive self-estimate (51), and, in another study, self-acceptance, defined as congruence between self-concept and ideal self, was found to be associated with low levels of anxiety and insecurity feelings (26). According to some other data, rebellious adolescents have lower ego-control or tension-binding capacity (inability to delay impulse gratification), more extreme self-esteem scores (feelings of exaggerated worth or inferiority), and more inadequate ego-ideal formation than do subjects of a control group (159).

Studies of time orientation and time perspective are relevant to the present discussion because these variables appear to be related to aspects of ego-control, such as abilities to bind tensions, delay gratifications, and control impulses. Among boys in a residential school for emotionally disturbed children, those who could not maintain good behavior in the absence of immediate rewards (i.e., could not delay gratification) experienced time periods as passing slowly in experimental tests and showed significant constriction of time conception (106).

The significance of present vs. future orientation may vary with age during childhood. Among eleven-year-old children, present orientation was related to stability of friendships, a sign of maturity, while a high degree of future orientation was associated with inadequate personal and social adjustment (43). At a later age, however, future orientation may be a sign of good adjustment. High achievers in junior high school had significantly greater

future time-perspective than did low achievers, and optimism and future orientation were positively correlated (175).

Findings such as these are only preliminary and uninformative about the determinants of the self and self-conception. The relationships among needs, social conditions, and ego functioning need to be explored. Clearly, the surface of this important research area is just beginning to be scratched.

SOCIAL BEHAVIOR AND SOCIAL RELATIONSHIPS

There is no real field of developmental social psychology; rather, there are problems and hypotheses, conventionally assigned to the area of social psychology, which are investigated with children as subjects. The results of such studies often contribute to the growing body of knowledge in both social psychology and developmental psychology. Judging from last year's publications, the fields of personality and social psychology are becoming less and less differentiable. Most of the studies reviewed in this section concern personality characteristics as determinants of social status and social behavior.

In spite of a substantial body of theory and the availability of acceptable research techniques, no studies of interactions among children, in large or small groups, came to the reviewer's attention. The influence of the peer group on children's cognitive processes, personalities, and social behavior is assumed to be profound, and is often used as an explanation for research findings. Nevertheless, with the exception of one minor survey study of adults' memories of their adolescent "gang" memberships (37), no direct evidence of such influences, or material on the ways they function, was presented.

Social status.—Studies of the personality determinants of social status, generally assessed by sociometric analysis, continue to attract a great deal of research attention. Among Marshall's (118) rural groups (4-H clubs), social acceptability appeared to be a general characteristic which had a low positive correlation with age and with achievement in relevant group projects. In Elkins' (49) comprehensive study, the most popular eighth grade children play "a far greater total number of roles in the group as well as possessing attributes in accord with values of the group." The least chosen children, on the other hand, seemed rigid in role performance and unable to meet the needs of peers; they displayed certain objectionable behavior patterns. The highly chosen tended to be younger, more intelligent, and higher in socioeconomic status, and they received better academic grades; they visited with peers often outside of school. According to interviews with parents and children, children who experience satisfactory family relationships develop a "sense of belonging" which is conducive to popularity with peers, while children who lack satisfactory family relationships are infrequently chosen by their peers (49). Among both normal and emotionally disturbed students, the most popular children were judged by adults who knew them well to be better adjusted emotionally than those who were popular (42, 121).

High school boys and girls who were socially active (as judged by frequency of mention in the school paper) did not differ from those who were inactive in age or intelligence, but classmates and adults rated the "actives" higher in prestige traits (popularity and friendliness). Follow-up data indicate that, in general, patterns of high-school participation tend to persist into adult life (90).

Social power and leadership influences.—Three excellent experimental studies addressed themselves to the problem of the characteristics and behavior of individuals who can influence children's behavior or attitudes, or both. Zander & Van Egmond (196) found that, for both boys and girls in the second and fifth grades, social power as rated by classmates had a low, though significant, positive correlation with intelligence and with ratings of attractiveness. Boys seem to acquire social power on the basis of being threatening, girls by being socially skilled and well behaved. In problem-solving discussions among boys, possession of either social power or high intelligence led to vigorous and successful participation in the group's work, while possession of low power and low intelligence together generated passivity (less attempt to influence others and less success). Boys low in intelligence but high in power were somewhat inconsistent and coercive in their social behavior, while greater intelligence evoked consistency and readiness to be considerate in relations with others.

Two related experiments by Brigante (23) were concerned with the determinants of adolescents' responses to adult power-figures. In one experiment, 27 subjects solved problems and then heard judges with differing power over the subject make recommendations about the problem solutions. While rewarding judges were rated more favorably than neutral or punishing figures, there were no significant differences in extent of immediate influence by different power-figures, and, a week later, the neutral figure appeared to be more influential than did the rewarder and the low punisher. In the second experiment, dealing with the effects of father-son relationships and manifest inferiority feelings on reactions to power figures, 50 boys were interviewed by three judges having different degrees of power to give and deduct "points." Boys who disagreed strongly with fathers' disciplinary methods were more likely than those low in disagreement to be responsive to power gradations, rating rewarders higher than neutral figures or punishers. Subjects of moderate inferiority feelings rated power figures more favorably than did those high in inferiority feelings. In brief, the extent to which an adult can influence a child seems to depend, not only on the adult's power, but, also, on the personality of the child he is attempting to influence.

Kipnis (95) investigated the relative efficacy of different leadership techniques—participatory vs. lecture styles and rewarding compliance or punishing noncompliance—in inducing children to change their own attitudes (in this case, toward comic books) in the direction of the leader's attitudes. Both reward (promise of movie passes) and punishment (threat to deprive subjects of movie passes) produced more public compliance than control

conditions. Participatory leadership with a neutral or rewarding leader was more effective than lecture leadership in changing children's private beliefs, but this kind of leadership, combined with threat of punishment, induced only a few subjects to change their private beliefs. Under lecture leadership, the punishment threat was highly effective.

Influences of mass media.—Despite their obvious practical importance and potential theoretical significance, there have been very few systematic psychological studies of the effects of mass media on children. Two outstanding studies published during the past year help to fill some major gaps (8, 75). Bailyn's study (8) of over 600 fifth- and sixth-grade pupils viewed exposure to mass media in the context of social and personality variables. Questionnaires administered to the children supplied the basic information on (a) habits of exposure to the pictorial media (television, movies, and comic books), (b) program and reading preferences, (c) social background, and (d) personality characteristics. The four factors most highly associated with high exposure to these media were, in order of importance: lack of parental restriction on amount of exposure, low IQ, working class status, and being a Catholic. Girls' habits of media exposure had no significant cognitive correlates, but boys in the high-exposure group, who had many problems and were extrapunitive and rebelliously independent, tended to be generally passive in attitude and to classify in stereotyped ways. Their fantasy self-images were colored by the mass media which they used as an escape.

A group of English investigators (75) was chiefly concerned with children's preferences and the effects of television on children's interests, personal relationships, and educational progress. Their study involved comparisons of matched groups of over 1800 viewers and nonviewers between 10 and 11 and between 13 and 14 years of age, as well as a before-and-after design. Like Bailyn, they found that intelligence was inversely related to the amount of television viewing, and among the younger group (comparable in age with Bailyn's subjects) heavy viewing was more frequent among working-class children. More intelligent children not only devoted less time to television, but were less affected by the values and knowledge television offered. Older, less intelligent viewers tended to be more ambitious and success-oriented than nonviewers, and adolescent girls proved to be more responsive than boys to television's impact. Personality characteristics, particularly insecurity and maladjustment, have significant effects on television addiction.

The active child, socially at ease, and with a happy home background, is the least likely to become preoccupied by television. On the other hand, children who view a great deal do so (particularly the intelligent ones) because they have difficulties in making friends or problems in their family relations (75).

At the points in the two studies at which the data are comparable, the results appear to be quite similar. While the English study appears to have a more "applied" flavor, attempting to arrive at answers to some very practical problems, both studies agree in one essential point: the mass media can have

marked effects on children's thought processes and values, but the kind and degree of these effects will vary with the characteristics of the child exposed to the media. In short, mass media influences may be resisted, just as leadership influences can be.

Conformity and compliance.—In view of the tremendous number of social pressures on people, social scientists have become very much concerned with inner vs. outer directedness, or individuality and resistance to social pressure vs. conformity and yielding to social influence. An excellent study of nursery- and primary-school children showed that the quality of social compliance changes with age (36). Compliant nursery school children are characterized by a dependent orientation towards others and, to a lesser degree, a lack of aggressive and dominating behavior and more "other directedness" (i.e., more attention-seeking). At the same time, they were more energetic and spontaneous, more outgoing, relaxed, flexible, and self-accepting. Among older children, compliance appears to be a more general characteristic, associated with some constriction of personality, lack of assertiveness, high receptivity to the influence of others, and indirect manifestations of dependency.

McDavid (120) studied directly the relationship between a broad personality-social dimension and the tendency to yield to group pressure. His subjects were two groups of male high-school juniors who, on the basis of their sentence completions, were categorized as source-oriented (tending to respond in terms of the source of the communication) or message-oriented (tending to respond in terms of the message or content). They were observed in an experimental situation in which two anonymous "peers" reported judgments of an auditory counting-task before the subject reported his own judgment. The source-oriented group appeared to be more susceptible to group pressure and conformed in order to avoid being different from the group, yielding as often in easy, as in difficult, tasks.

Values and attitudes.—Two studies (125, 170) of the responses of young Southern Negro and white children on tests of racial awareness and racial attitudes showed that the ability to discriminate between the races developed rapidly during the preschool years—especially during the fifth year (125)—and at an earlier age among white children. Racial stereotypes are accepted by youngsters, Negro children discussing racial membership reluctantly (125), rejecting other Negroes in their selection of playmates and guests at a party, etc., and assigning negative roles to Negro children (170). A survey of the values of delinquent boys showed a primary emphasis on materialism and gratification orientation, with little value for "inner directed" character traits (180).

The most impressive work in this area during the past year was Kutner's study (97) of the cognitive functioning (patterns of thought and problem-solving) of prejudiced children. An Ethnic Attitude Test was used to divide 60 second-grade children into a more and a less prejudiced group, matched in sex, age, religion, father's occupation, and IQ. The responses of the two

groups to cognitive tests differed tremendously. In a concept-formation task, prejudiced children were less capable of arriving at adequate concepts and tended to jump to conclusions. Deductive reasoning problems, involving both formal logic and more ambiguous situations, elicited more invalid conclusions from the prejudiced children. Moreover, these children were less capable of dealing in logical fashion with ambiguous problems than they were with clearcut problems of formal logic. In problem-solving tests, unprejudiced children were more task-oriented, less likely to become discouraged and perplexed, and showed more insight and understanding than their more prejudiced peers. The patterns of cognitive functioning of the prejudiced children had two major characteristics: mental rigidity and intolerance of ambiguity. These patterns reflect the fundamental motivational and emotional structures and needs of the individuals; i.e., they are part of more general factors in personality organization.

While attitudes and values are intimately related to basic personality patterns and to modes of thought, it is also true that environmental manipulations may produce changes in attitude. This was reaffirmed in an interesting experimental study of children's attitudes towards cheating, testing hypotheses derived from Festinger's theory of cognitive dissonance (55). Mills (123) predicted that children who decide not to cheat when tempted will become more severe in their attitudes towards cheating; those who cheat will become more lenient. The greater the motivation to cheat and the lower the restraints against cheating, the more those who are honest will increase in severity toward cheating; the less the motivation to cheat, and the higher the restraints against it, the more lenient those who cheat will become. Questionnaires measuring attitudes towards cheating were administered to 24 sixth-grade classes before and after a contest which provided them with an opportunity to cheat or to be honest. Motivation to cheat was varied by offering prizes of different value for winning, and restraints were manipulated by making it easier for some groups to falsify their scores.

The overall changes for those who did and did not cheat confirm the main hypothesis; i.e., those who are honest increased in severity of attitudes toward cheating, and those who cheated decreased. Moreover, as predicted, those who were honest under conditions of high motivation and low restraint increased significantly more in their severity toward cheating than the control group did (123).

Interpersonal communication.—In a provocative speculative essay, *No and Yes*, Spitz (165) presents a complex developmental theory of communication, derived from psychoanalysis and ethology. According to this theory, the beginnings of human communication may be seen in the cephalogyric motions of the infant. Emotionally deprived infants make "negative cephalogyric motions" (head shaking) in refusing contact, regressing to the innate response of "rooting behavior" (the newborn's head movements in seeking the nipple). Head shaking, semantic "No" on the other hand, is adaptive and is acquired through identification with the parent after the gesture has

been used in rooting behavior and then in refusal of the nipple after satiation. The acquisition of these gestures is of primary importance because they permit the ego to deal with the environment and the self. The "No" gesture is "the indicator of a new level of autonomy, of the awareness of the other, and of the awareness of the self; it initiates an extensive ego-development."

The theory is intriguing and well presented, but it lacks rigor and is over-inclusive. The links between communication functions and ego development are not entirely clear. Its major difficulty, however, is the extreme difficulty, or even impossibility, of subjecting it to empirical test. This last criticism applies as well to Bixler & Yeager's "theory," in which the origins of language are interpreted in terms of operant conditioning, beginning with reinforcing the sound "mama" (18).

Motivational orientations in communication were studied developmentally by means of interviews with Australian adolescents between the ages of 12 and 16 (133). Responses to questions about their discussions with peers on a variety of topics (e.g., sports, religion, parents) were classified as primarily "informational" (concerned with objective qualities of objects or persons or both) or "narcissistic" (concerned with drawing attention to the self). Within the age groups studied, orientations change with age, informational responses increasing proportionately and narcissistic responses decreasing. Informational percentages exceed narcissistic percentages at all age levels for both sexes, but boys are relatively more informationally inclined while girls are more narcissistically oriented.

Play.—Papers on the use of play in diagnosis and therapy abound (e.g., 52, 99), but research into the social psychology of play is missing. The only relevant research published during the year was a simple correlational study showing that children of high intelligence are more likely than those of less intelligence to favor play activities that demand intelligence and basic skills (185)! A purely theoretical paper by Alexander (3) elaborated the psychoanalytic conception of play as one of the manifestations of sexuality, the exercise of surplus libidinal energy not required for survival. Playing for pleasure is an aim in itself, although through play skills are perfected, threatening situations are mastered, and problems are solved.

CHILDREN'S LEARNING

The use of the experimental method in developmental psychology is most adequately demonstrated in studies of the learning process. Traditionally, these studies were concerned with basic issues of learning theory and any contribution they made to developmental psychology was purely incidental. More recently, however, researchers have applied their theoretical frames of reference to uniquely human kinds of learning, designing and conducting experiments directly concerned with children's acquisition of responses and psychological characteristics.

Methodology.—Terrell (176) stresses the methodological advantages of experiments involving simple learning rather than more complex phenomena,

concluding that the most substantial and extensive knowledge of development can be derived by this approach. The argument is closely reasoned and has merit, but the conclusion is probably not entirely acceptable to many developmental psychologists. An equally good case could be made for the position that complex, multiply determined responses can be understood only by direct study, perhaps in the home rather than in the laboratory, (158) or by clinical methods, or by both.

Focusing on more technical methodological problems, Bijou & Sturges (17) described the use of consumables (edibles) and "manipulatables" (toys) as reinforcers. The advantages of allowing children to select their own reinforcers from among several possibilities (20) and the conditions under which adult approval is most effective as a reinforcer (63) were also studied.

Discrimination learning and transposition.—The following conditions were found to facilitate simple discrimination learning in young children: rewarding correct responses and punishing incorrect ones rather than simply rewarding correct ones (21); penalizing incorrect responses, especially under conditions of nonsatiation for the reward objects (172); instructing subjects to verbalize cues (188); and using responses requiring lesser, rather than greater, effort and previous experience with the experimental apparatus (164). Moreover, it is easier to discriminate black-white than different colored stimuli (33), stereometric objects than planometric objects and patterns (169), and large or small than middle-sized stimuli (169).

Several studies comparing the performances of normal and mentally retarded children in a variety of discrimination-learning problems showed that the rate of learning the discriminations and acquiring learning sets is a function of intellectual level (78, 79, 94, 171). Differences between normal and retarded groups hold even when the groups are matched in mental age (79). Analysis of the performance of the retarded children shows that they characteristically make many stimulus perseveration errors (94) and irrelevant responses (171) during learning trials. In motor learning, stress (time pressure) increases the strength of a dominant tendency, but impairs the learning of each new response which is incompatible with the dominant tendency (32).

Spence's component theory explanation of transposition and Kuenne's distinction between verbal and preverbal modes of learning continue to be challenged. Rudel (148) contrasted the performances of verbal and preverbal children in positive and negative tests of transposition on extended stimulus continua. The groups did not differ in their transposition responses and there were significantly more relational responses on trials requiring transposition in the negative than in the positive direction. Transposition in a positive direction produced a U-curve; that is, there was as much transposition with test pairs at a great distance from the training pairs as with test pairs close to the original pair. Gonzalez & Ross (66) trained a group of preverbal children on two widely separated sets of stimuli, and then tested for transposition with a new set lying between the two training sets but far removed from

each. Almost all of the preverbal subjects transposed immediately on the test trial, and the transposition was stable. The authors conclude that their findings "force a change in the interpretation of the distance effect as a function of verbal ability."

Generalization.—Through the use of a training puzzle, Gewirtz (62) tested the effects of positive and negative reinforcement on children's preferences for puzzles of different degrees of similarity to the original puzzle. Negative reinforcement uniformly generated avoidance gradients, but positive reinforcement had different effects on the subjects, producing approach gradients in some and avoidance gradients in others. Further analysis indicated that these differences stemmed from personality variables, particularly in achievement needs. "Positively reinforced subjects who exhibited avoidance gradients tended to have superior IQs, and to verbalize preference for difficult tasks." Gewirtz's "teasing out" of personality variables related to a basic learning process makes this a notable contribution. London (116) explored experimentally the often-hypothesized relationship between maladjustment and overgeneralization in affective and nonaffective situations. The subjects, 80 maladjusted and 87 normal boys matched in age and intelligence, were given a generalization test consisting of six sets of graded stimuli, three of which had social properties. Age and ability to make discriminations were correlated, the relationship being significantly stronger for the normal than for the maladjusted boys. Moreover, as predicted, the maladjusted boys tended to generalize responses relatively more than normal children on all the tests, especially on those with social properties.

Social learning and imitation.—Of particular interest for developmental psychology are those experiments in which interpersonal variables are manipulated. In one study, reinforcement of each vocalization of three-month-old infants by smiling and lightly touching the abdomen resulted in a significantly greater number of vocalizations on the first day of conditioning, compared with control baseline days, with still further increases on the second day. Extinction occurred rapidly when the reinforcements were discontinued. Clearly, the social responsiveness of the infant, as reflected in his vocalizations, can be modified by social rewards (145).

Wilson (191) showed that preschool children learn imitation responses readily, and, while doing so, also learn secondary "incidental" cues. Learning a discrimination problem by this method appeared to be more efficient than trial-and-error.

Rosenblith's ingenious and methodologically sophisticated experiment (146) went much further in investigating imitation. Kindergarten children were given an opportunity to imitate a leader's solution to Porteus Maze Test items which they had previously failed. There were male and female leaders. With half the subjects, the leaders were attentive throughout a 10-minute period, while, with the other half, they withdrew attention after five minutes. Control group subjects had no contact with leaders or opportunity for copying. Amount of learning by imitation was measured by the number

of mazes passed. The chief findings were: that a model is more effective than are additional trials alone; girls are less sensitive to the experimental manipulations than boys are; male leaders are more effective than female leaders for both sexes; and continuous attention is more effective than withdrawal of attention, except in the case of boys with a male leader. The findings are interesting and valuable in themselves, but, in the reviewer's opinion, the paper is most remarkable for its presentation of methodology for investigating this crucially important kind of learning.

INTELLECTUAL DEVELOPMENT

Early development of intelligence.—Observations of idiots manipulating toys and solving sensorimotor problems suggest that the intellectual development of severe mental defectives follows the six-stage sequence described by Piaget as typical of the normal infant during the first two years (194).

Harms & Spiker (72) investigated the consistency of performance of infants between 16 and 30 months of age on two intelligence scales, the Cattell and Kuhlmann. The test-retest reliabilities of both tests, based on a short time-interval, were high, as were the correlations between the two tests. The scores on the two tests were significantly different, however, the Kuhlmann scale averaging 16 IQ points lower than the Cattell on both test and retest. These findings provide convincing evidence of the reliabilities of these infant tests, but many earlier studies indicate that the tests are of extremely limited usefulness for prediction of later intelligence.

Cultural differences in intelligence test performance.—The prediction of a child's intellectual development and academic progress from intelligence test scores is particularly difficult if the child's cultural background is different from that of the standardization group. Thus, although matched as closely as possible in age, sex, education, and rural-urban residence with Wechsler's WAIS standardization group, a group of Navaho adolescents had lower mean scores than the standardization group (80).

Walters (183) tested three groups of New Zealand Maori children and a control group of children of European descent on Thurstone's Primary Mental Abilities (PMA) and a nonlanguage test. Contrary to the usual findings on rural groups, the rural Maori surpassed the city and semirural groups in IQ, scoring almost as high as the controls, who did significantly better than either city or semirural groups. Generally speaking, the Maori groups did less well in comparison with the controls on the totally nonverbal test than they did on the PMA, leading the author to conclude "a great deal of doubt is cast on the general efficacy of nonverbal tests for the assessment of the intelligence of children who are culturally handicapped."

The findings of other studies reinforce this conclusion. Among English-speaking children of English-Welsh background, mean scores on a nonverbal intelligence scale were inversely correlated with the extent of the use of the Welsh language in the home (111). Negro and white lower-class children

with similar Stanford-Binet scores were found to differ significantly on the nonverbal Colored Raven Progressive Matrices Test (CRPM), the Negroes' means being lower than the whites' at all ages tested (74). Among pre-school and kindergarten Jewish children having the same Stanford-Binet IQs, those who are foreign-born have significantly lower mean vocabulary mental ages than the native-born (108), and native-born bilingual children are at a disadvantage in some kinds of tests and subtests (107).

Personal and environmental correlates of intelligence.—Moss & Kagan (126), continuing the excellent Fels studies on the correlates of intellectual development, found that the IQs of children at ages three and six were significantly positively correlated with maternal educational level and maternal IQ. A high degree of "maternal acceleration" (pushing the child) elevated boys', although not girls', intelligence-test scores at age three. The depressive effect of emotional disturbance on intellectual functions was inferred from the low degree of correlation between the IQs of disturbed children and their mothers (41). An unstimulating institutional environment may affect the intellectual functioning of mental defectives adversely. In one study, length of institutionalization was found to be inversely related to mental age and to ability to define words abstractly (7).

An extremely cogent and stimulating appraisal of the heredity-environment "controversy" was contributed by Anastasi (5). She suggests that the crucial question is not which factor is responsible, or how much of the variance is due to each, but rather how, i.e., what is the *modus operandi* of each factor. The two factors are interacting, rather than additive, characteristics; i.e., the contribution of heredity to the variance of a given trait will vary under different environmental conditions, and, similarly, under different hereditary conditions the relative contribution of the environment will differ.

COGNITIVE FUNCTIONS

Piaget's ideas continue to be the major inspiration of research in this area. Parsons & Milgram published a fine English translation of Inhelder & Piaget's work on logical thinking in adolescence (83), which represents the culmination of Piaget's systematic chronological study of cognitive development. The original French edition was reviewed in Inhelder's chapter "Developmental Psychology" in the 1957 edition of the *Annual Review of Psychology* (82). The translator's introduction summarizes Piaget's major research and relates the present report to the earlier work.

Jahoda's examination of cross-cultural data (86) and his own research with children in Ghana (87) confirm major aspects of Piaget's theory of animism. His data indicate that animistic responses to questions about causation were frequent among young children, but progressively declined with age.

Piaget's "clinical method" was the technique used in two Australian

investigations of concept formation. In one study (39, 40), it was found that children's concepts of economic relationships develop in stages, the earliest stage involving no real understanding and having ritualistic aspects. Reciprocity in such matters as boss-worker relationship is grasped later, while realization that economic relationships are part of a total economic system occurs relatively late. According to the other study (40), children's explanations of eight types of growth and movement (e.g., growth of plants and animals, flight of birds and airplanes) develop in a sequence of four discontinuous stages: simple action of a single agent, two factors acting independently, two factors interacting, interactions among many parts producing a total effect. These findings seem to be consistent with Piaget's notions of stages of development, but since the data were not fully reported, it is difficult to evaluate the conclusions.

Children's ideas of justice were studied in West Africa and in America (46, 88). Ghanaese children's answers to questions about a story character who cut his foot after stealing some oranges showed that, with increasing age, there was a significant decrease in "pure immanence" and a significant increase in "naturalistic" explanations (88). The justice concepts of American children in the second, fifth, and eighth grades are significantly related to age, but there was no evidence that acceptance of reciprocity as a justice principle increases with age. In fact, the oldest children tended to seek justice in authority individuals more frequently than did younger children. Older children expressed more concern about mitigating factors in the situation, however (46).

In accounting for inconsistencies in someone else's behavior, some children use inferences and concepts, others do not. These differences are correlated with age, sex, intelligence, and socioeconomic status. Children's impressions of people are not invariably unified, but increase in integration with increasing age (65). The development of standard time concepts appears to occur abruptly at about the age of eight, children over this age showing considerable accuracy in estimating seconds, especially if kinaesthetic cues are available (64).

PHYSICAL AND PERCEPTUAL DEVELOPMENT

Physical growth and change.—Investigations of a number of factors influencing physical growth and development were reported. Maternal rubella during the first 18 weeks of pregnancy may produce hearing defects in the infant (85). Very small prematurely born children (1000 gm. or less) achieved normal stature later and had a higher incidence of visual defects and lower IQs than their fullterm siblings (38). Malnutrition in infancy and early childhood may delay the appearance of ossification centers (45). There are no sex differences in thickness of fat in neonates, but females have a higher fat-weight ratio than males. Fatter neonates tend to be longer and to weigh more, but gain less weight during the early postnatal period (60). Uganda

infants in the first year of life are more advanced than European children in postural and motor abilities (61). With the exception of the endomorphic component, somatotypes tend to be fairly stable and consistent from early adolescence through adulthood, the major growth in males being in the mesomorphic components and in females in the endomorphic (197). In general, there is no evidence of a temporary decrease in physiological stability or of a period of height variability during adolescence (48).

Perceptual development.—Fantz (53) observed the direction and duration of visual fixations of very young infants (1 to 14 weeks of age) when pairs of patterns were exposed. Consistent visual preferences were present as early as the first two months. Berlyne (14) presented evidence that infants between three and nine months of age preferred (i.e., fixated) patterns with more contour. Seventeen-year-olds were significantly more accurate in size estimation and had a lower interval of uncertainty than five-, seven-, and twelve-year-olds (34). Movement thresholds in young children have also been studied (31); experiments on auditory localization and adaptation to body tilt over the age range six to eighteen showed that young children's spatial orientation is less determinant and more labile than the adult's (113).

SURVEYS AND TEXTS

One new textbook of child psychology (186), three revisions of older ones (67, 81, 130), one book of readings (157), and one laboratory manual for research courses in child development (173) appeared during the year. There was one general nontechnical book on family relationships (2) and a "guide to help parents" of adolescents (59), a survey of social and economic census data on children (16), and a report of a conference on child development (174). In addition to research summaries encompassed in texts and theoretical articles reviewed above, there was a fine review-discussion on maturation and behavior (47). The December, 1958, issue of the *Review of Educational Research* summarized the past three years' work in growth, learning, and development, including research on physical growth (89) and mental abilities (138).

SUMMARY

A summary chapter such as this one necessarily gives the impression that developmental psychology grows by haphazard accretion of bits and pieces of data. Actually, however, last year's publications contain many signs of scientific maturing. There are proportionately fewer purely descriptive, normative studies and more studies geared to the "whys" of children's behavior. This inevitably makes for a closer integration of theory and research, and, ultimately, a more tightly knit body of knowledge. The problem of how to be rigorous while working on socially important problems is still a bothersome one, especially in view of the increasing realization that human devel-

opment can be understood only in the contexts of the immediate, as well as the general, social psychological environment. Certainly there is no general agreement about the "best" philosophy of methodology for the field, but there is a great deal of self-consciousness about methods among investigators, research designs are improving, and better techniques are being discovered. The recent trends are best illustrated in the programmatic studies reviewed above, in which, generally speaking, theory directs methodologically sophisticated research—often conducted collaboratively by teams of investigators with different training and skills—on important problems. Programmatic research has been relatively rare in this field, but, hopefully, this is the direction in which we are moving. Other fields of science, including other areas of psychology, have gained most substantially from integrated programs of studies and experiments, and there is every reason to believe that developmental psychology will also advance faster and further by the same route.

LITERATURE CITED

1. Abbe, A. E. Maternal attitudes toward child behavior and their relationship to the diagnostic category of the child. *J. Genet. Psychol.*, **92**, 167-73 (1958)
2. Ackerman, N. W. *The Psychodynamics of Family Life: Diagnosis and Treatment of Family Relationships* (Basic Books, Inc., New York, N. Y., 379 pp., 1958)
3. Alexander, F. A contribution to the theory of play. *Psychoanal. Quart.*, **27**, 175-93 (1958)
4. Alt, H. Basic principles of child rearing in the Soviet Union: firsthand impressions of an American observer. *Am. J. Orthopsychiat.*, **28**, 223-40 (1958)
5. Anastasi, A. Heredity, environment, and the question "how?." *Psychol. Rev.*, **65**, 197-208 (1958)
6. Antonovsky, H. F. A contribution to research in the area of the mother-child relationships. *Child Development*, **30**, 37-51 (1959)
7. Badt, M. I. Levels of abstraction in vocabulary definitions of mentally retarded school children. *Am. J. Mental Deficiency*, **63**, 241-46 (1958)
8. Bailyn, L. Mass media and children: a study of exposure habits and cognitive effects. *Psychol. Monographs*, **73**, 48 pp. (1959)
9. Baldwin, A. L., and Levin, H. Effects of public and private success or failure on children's repetitive motor behavior. *Child Development*, **29**, 363-72 (1958)
10. Barry, H., Child, I. L., and Bacon, M. K. Relation of child training to subsistence economy. *Am. Anthropologist*, **61**, 51-63 (1959)
11. Bell, R. Q. Retrospective attitude studies of parent-child relations. *Child Development*, **29**, 323-38 (1958)
12. Beller, E. K. Exploratory studies of dependency. *Trans. N. Y. Acad. Sci.*, **21**, 414-26 (1959)
13. Bene, E. A Rorschach investigation into the mothers of autistic children. *Brit. J. Med. Psychol.*, **31**, 226-27 (1958)
14. Berlyne, D. E. The influence of the albedo and complexity of stimuli on visual fixation in the human infant. *Brit. J. Psychol.*, **49**, 315-18 (1958)
15. Bernabeu, E. P. The effects of severe crippling on the development of a group of children. *Psychiatry*, **21**, 169-94 (1958)
16. Bernert, E. H. *America's Children* (John Wiley & Sons, Inc., New York, N. Y., 185 pp., 1958)
17. Bijou, S. W., and Sturges, P. T. Positive reinforcers for experimental studies with children—consumables and manipulables. *Child Development*, **30**, 151-70 (1959)
18. Bixler, R. H., and Yeager, H. C., Jr. It may have begun with "Mama." *Psychol. Repts.*, **4**, 471-75 (1958)
19. Block, Jack, Patterson, V., Block, Jeanne, and Jackson, D. A study of the parents of schizophrenic and neurotic children. *Psychiatry*, **21**, 387-97 (1958)
20. Brackbill, Y., and Jack, D. Discrimination learning in children as a function of reinforcement value. *Child Development*, **29**, 185-90 (1958)
21. Brackbill, Y., and O'Hara, J. The relative effectiveness of reward and punishment for discrimination learning in children. *J. Comp. Physiol. Psychol.*, **51**, 747-51 (1958)
22. Brandt, R. M. The accuracy of self estimate: A measure of self-concept reality. *Genet. Psychol. Monographs*, **58**, 55-100 (1958)

23. Brigante, T. R. Adolescent evaluation of rewarding, neutral, and punishing power figures. *J. Personality*, **26**, 435-50 (1958)
24. Bronson, W. C., Katten, E. S., and Livson, N. Patterns of authority and affection in two generations. *J. Abnormal Social Psychol.*, **58**, 143-52 (1959)
25. Brown, D. G. Sex-role development in a changing culture. *Psychol. Bull.*, **55**, 232-42 (1958)
26. Bruce, P. Relationship of self-acceptance to other variables with sixth grade children oriented in self-understanding. *J. Educ. Psychol.*, **49**, 229-38 (1958)
27. Bull, K. R. An investigation into the relationship between physique, motor capacity and certain temperamental traits. *Brit. J. Educ. Psychol.*, **28**, 149-54 (1958)
28. Burchinal, L. G. Social status, measured intelligence, achievement, and personality adjustment of rural Iowa girls. *Sociometry*, **22**, 75-80 (1959)
29. Burchinal, L. G., Gardner, B., Hawkes, G. R. Children's personality adjustment and the socio-economic status of their families. *J. Genet. Psychol.*, **92**, 149-59 (1958)
30. Calogeras, R. C. Some relationships between fantasy and self-report behavior. *Genet. Psychol. Monographs*, **58**, 273-325 (1958)
31. Carpenter, B., and Carpenter, J. T. The perception of movement by young chimpanzees and human children. *J. Comp. Physiol. Psychol.*, **51**, 782-84 (1958)
32. Castaneda, A., and Lipsitt, L. P. Relation of stress and differential position habits to performance in motor learning. *J. Exptl. Psychol.*, **57**, 25-30 (1959)
33. Clifford, L. T., and Calvin, A. D. Effect of age on the discriminative learning of color and brightness by children. *Am. J. Psychol.*, **71**, 766-67 (1958)
34. Cohen, W., Heshkowitz, A., and Chodack, M. Size judgment at different distances as a function of age level. *Child Development*, **29**, 473-79 (1958)
35. Coulter, W. M. The Szondi test and the prediction of antisocial behavior. *J. Projective Techniques*, **23**, 24-29 (1959)
36. Crandall, V. J., Orleans, S., Preston, A., and Rabson, A. The development of social compliance in young children. *Child Development*, **29**, 429-44 (1958)
37. Crane, A. R. Symposium: the development of moral values in children. *Brit. J. Educ. Psychol.*, **28**, 201-8 (1958)
38. Dann, M., Levine, S. Z., and New, E. V. The development of prematurely born children with birth weights or minimal postnatal weights of 1,000 grams or less. *Pediatrics*, **22**, 1037-53 (1958)
39. Danziger, K. Children's earliest conceptions of economic relationships (Australia). *J. Social Psychol.*, **47**, 231-40 (1958)
40. Danziger, K., and Sharp, N. The development of children's explanations of growth and movement. *Australian J. Psychol.*, **10**, 196-207 (1958)
41. Davids, A. Intelligence in childhood schizophrenics, other emotionally disturbed children, and their mothers. *J. Consulting Psychol.*, **22**, 159-63 (1958)
42. Davids, A., and Parenti, A. N. Personality, social choice, and adults' perception of these factors in groups of disturbed and normal children. *Sociometry*, **21**, 212-24 (1958)
43. Davids, A., and Parenti, A. N. Time orientation and interpersonal relations of emotionally disturbed and normal children. *J. Abnormal Social Psychol.*, **57**, 299-305 (1958)

44. Doris, J. Test-anxiety and blame-assignment in grade school children. *J. Abnormal Social Psychol.*, **58**, 181-90 (1959)
45. Dreizen, S., Snodgrass, R., Webbeploe, H., and Spies, T. The retarding effect of protracted undernutrition on the appearance of the postnatal ossification centers in the hand and wrist. *Human Biology*, **30**, 253-64 (1958)
46. Durkin, D. Children's concepts of justice: a comparison with the Piaget data. *Child Development*, **30**, 59-67 (1959)
47. Eichorn, D. H., and Jones, H. E. Maturation and behavior. *Current Psychological Issues*, Chap. 9, 211-47 (Henry Holt & Co., Inc., New York, N. Y., 360 pp., 1958)
48. Eichorn, D. H., and McKee, J. P. Physiological instability during adolescence. *Child Development*, **29**, 255-68 (1958)
49. Elkins, D. Some factors related to the choice-status of ninety eighth-grade children in a school society. *Genet. Psychol. Monographs*, **58**, 207-72 (1958)
50. Elkins, E. The diagnostic validity of the Ames "danger signals." *J. Consulting Psychol.*, **22**, 281-87 (1958)
51. Engel, M. The stability of the self-concept in adolescence. *J. Abnormal Social Psychol.*, **58**, 211-15 (1959)
52. Erickson, F. H. Play interviews for four-year-old hospitalized children. *Monographs Soc. Research Child Development*, **23**, 77 pp. (1958)
53. Fantz, R. L. Pattern vision in young infants. *Psychol. Record*, **8**, 43-47 (1958)
54. Feather, N. T. Level of aspiration and achievement imagery. *Australian J. Psychol.*, **10**, 319-28 (1958)
55. Festinger, L. *Introduction to a Theory of Cognitive Dissonance* (Row, Peterson & Co., Evanston, Ill., 291 pp., 1957)
56. Fineman, A. D. Preliminary observations on ego development in children with congenital defects of the genitourinary system. *Am. J. Orthopsychiat.*, **29**, 110-20 (1959)
57. Fox, C., Davidson, K., Lighthall, F., Waite, R., and Sarason, S. B. Human figure drawings of high and low anxious children. *Child Development*, **29**, 297-302 (1958)
58. Freeman, H. E., Simmons, O. G., and Bergen, B. J. Possessiveness as a characteristic of mothers of schizophrenics. *J. Abnormal Social Psychol.*, **58**, 271-73 (1959)
59. Gallagher, J. R., and Harris, H. I. *Emotional Problems of Adolescents* (Oxford University Press, New York, N. Y., 174 pp., 1958)
60. Garn, S. M. Fat, body size and growth in the newborn. *Human Biology*, **30**, 265-80 (1958)
61. Geber, M. The psycho-motor development of African children in the first year, and the influence of maternal behavior. *J. Social Psychol.*, **47**, 185-95 (1958)
62. Gewirtz, H. B. Generalization of children's preferences as a function of reinforcement and task similarity. *J. Abnormal Social Psychol.*, **58**, 111-18 (1959)
63. Gewirtz, J. L., and Baer, D. M. Deprivation and satiation of social reinforcers as drive conditions. *J. Abnormal Social Psychol.*, **57**, 165-72 (1958)
64. Goldstone, S., Boardman, W. K., and Lhamon, W. Kinesthetic cues in the development of time concepts. *J. Genet. Psychol.*, **93**, 185-90 (1958)
65. Gollin, E. S., Organization characteristics of social judgment: a developmental investigation. *J. Personality*, **26**, 139-54 (1958)

66. Gonzales, R. C., and Ross, S. The basis of solution by preverbal children of the intermediate-size problem. *Am. J. Psychol.*, **71**, 742-46 (1958)
67. Goodenough, F. L., and Tyler, L. E. *Developmental Psychology*, 3rd ed. (Appleton-Century-Crofts, Inc., New York, N. Y., 522 pp., 1959)
68. Granick, S., and Schefflen, N. A. Approaches to reliability of projective tests with special reference to the Blacky pictures test. *J. Consulting Psychol.*, **22**, 137-41 (1958)
69. Gray, S. W. Perceived similarity to parents and adjustment. *Child Development*, **30**, 91-107 (1959)
70. Greene, W. A., Jr., and Miller, G. Psychological factors and reticuloendothelial disease: IV. Observations on a group of children and adolescents with leukemia; an interpretation of disease development in terms of the mother-child unit. *Psychosomat. Med.*, **20**, 124-44 (1958)
71. Harlow, H. F. The nature of love. *Am. Psychologist*, **13**, 673-85 (1958)
72. Harms, I. E., and Spiker, C. C. Factors associated with the performance of young children on intelligence scales and tests of speech development. *J. Genet. Psychol.*, **94**, 3-22 (1959)
73. Hartup, W. W. Nurturance and nurturance-withdrawal in relation to the dependency behavior of preschool children. *Child Development*, **29**, 191-202 (1958)
74. Higgins, C., and Sivers, C. H. A comparison of Stanford-Binet and Colored Raven Progressive Matrices IQs for children with low socioeconomic status. *J. Consulting Psychol.*, **22**, 465-68 (1958)
75. Himmelweit, H., Oppenheim, A. N., and Vince, P. *Television and the Child* (Oxford University Press, New York, N. Y., 522 pp., 1958)
76. Hoffman, M. L., Mitsos, S. B., and Protz, R. E. Achievement striving, social class, and test anxiety. *J. Abnormal Social Psychol.*, **56**, 401-3 (1958)
77. Holloway, H. D. Reliability of the children's manifest anxiety scale at the rural third grade level. *J. Educ. Psychol.*, **49**, 193-96 (1958)
78. House, B. J., and Zeaman, D. Reward and nonreward in the discrimination learning of imbeciles. *J. Comp. Physiol. Psychol.*, **51**, 614-18 (1958)
79. House, B. J., and Zeaman, D. A comparison of discrimination learning in normal and mentally defective children. *Child Development*, **29**, 411-16 (1958)
80. Howell, R. J., Evans, L., and Downing, L. N. A comparison of test scores for the 16-17-year age group of Navaho Indians with standardized norms for the Wechsler Adult Intelligence Scale (Arizona and New Mexico). *J. Social Psychol.*, **47**, 355-59 (1958)
81. Hurllock, E. B. *Developmental Psychology*, 2nd ed. (McGraw-Hill Book Co., Inc., New York, N. Y., 645 pp., 1959)
82. Inhelder, B. Developmental psychology. In *Annual Review of Psychology*, **8**, 139-62 (Farnsworth, P., and McNemar, Q., Eds., Annual Reviews, Inc., Palo Alto, Calif., 502 pp., 1957)
83. Inhelder, B., and Piaget, J. *The Growth of Logical Thinking* (Basic Books, Inc., New York, N. Y., 356 pp., 1958)
84. Inselberg, R. M. The causation and manifestations of emotional behavior in Filipino children. *Child Development*, **29**, 249-54 (1958)
85. Jackson, A. D. M., and Fisch, L. Deafness following maternal rubella. *Lancet*, **II**, 1241-44 (1958)

86. Jahoda, G. Child Animism: I. A critical survey of cross-cultural research. *J. Social Psychol.*, **47**, 197-212 (1958)
87. Jahoda, G. Child Animism: II. A study in West Africa. *J. Social Psychol.*, **47**, 213-22 (1958)
88. Jahoda, G. Immanent justice among West African children. *J. Social Psychol.*, **47**, 241-48 (1958)
89. Jensen, K. Physical growth. *Rev. Educ. Research*, **28**, 375-91 (1958)
90. Jones, M. C. A study of socialization patterns at high school level. *J. Genet. Psychol.*, **93**, 87-112 (1958)
91. Jones, M. C., and Mussen, P. H. Self-conceptions, motivations, and interpersonal attitudes of early- and late-maturing girls. *Child Development*, **29**, 491-502 (1958)
92. Kagan, J. The concept of identification. *Psychol. Rev.*, **65**, 296-305 (1958)
93. Kagan, J. Socialization of aggression and the perception of parents in fantasy. *Child Development*, **29**, 311-20 (1958)
94. Kaufman, M. E., and Peterson, W. M. Acquisition of a learning set by normal and mentally retarded children. *J. Comp. Physiol. Psychol.*, **51**, 619-21 (1958)
95. Kipnis, D. The effects of leadership style and leadership power upon the inducement of an attitude change. *J. Abnormal Social Psychol.*, **57**, 173-80 (1958)
96. Knapen, M. T. Some results of an inquiry into the influence of child-training practices on the development of personality in a Bacongo society (Belgian Congo). *J. Social Psychol.*, **47**, 223-29 (1958)
97. Kutner, B. Patterns of mental functioning associated with prejudice in children. *Psychol. Monographs*, **72**, 48 pp. (1958)
98. Lambert, W. W., Triandis, L. M., and Wolf, M. Some correlates of beliefs in the malevolence and benevolence of supernatural beings: a cross-societal study. *J. Abnormal Social Psychol.*, **58**, 162-69 (1959)
99. Lebo, D. A theoretical framework for nondirective play therapy: concepts from psychoanalysis and learning theory. *J. Consulting Psychol.*, **22**, 275-79 (1958)
100. Lehmann, I. J. Responses of kindergarten children to the Children's Apperception Test. *J. Clin. Psychol.*, **15**, 60-3 (1959)
101. Lesser, G. S. Application of Guttman's scaling method to aggressive fantasy in children. *Educ. and Psychol. Measurement*, **18**, 543-51 (1958)
102. Lesser, G. S. Population differences in construct validity. *J. Consulting Psychol.*, **23**, 60-65 (1959)
103. Lesser, G. S. Religion and the defensive responses in children's fantasy. *J. Projective Techniques*, **23**, 64-68 (1959)
104. Leton, D. A. A study of the validity of parent attitude measurement. *Child Development*, **29**, 515-20 (1958)
105. Levin, H., and Baldwin, A. L. The choice to exhibit. *Child Development*, **29**, 373-80 (1958)
106. Levine, M., and Spivack, G. Incentive, time conception and self control in a group of emotionally disturbed boys. *J. Clin. Psychol.*, **15**, 110-13 (1959)
107. Levinson, B. M. Reevaluation of the revised Stanford-Binet Scale, Form L vocabulary as a test of intelligence for the kindergarten and primary school child. *J. Genet. Psychol.*, **93**, 237-48 (1958)
108. Levinson, B. M. A comparison of the performance of bilingual and monolingual

- native born Jewish preschool children of traditional parentage on four intelligence tests. *J. Clin. Psychol.*, **15**, 74-76 (1959)
109. Levy, D. M. *Behavioral Analysis* (Charles C Thomas, Publisher, Springfield, Ill., 370 pp., 1958)
110. Levy, E. Stimulus-values of Rorschach cards for children. *J. Projective Techniques*, **22**, 293-96 (1958)
111. Lewis, D. G. Bilingualism and non-verbal intelligence: a further study of test results. *Brit. J. Educ. Psychol.*, **29**, 17-22 (1959)
112. Liddle, G. The California Psychological Inventory and certain social and personal factors. *J. Educ. Psychol.*, **49**, 144-49 (1958)
113. Liebert, R. S., and Rudel, R. G. Auditory localization and adaptation to body tilt: a developmental study. *Child Development*, **30**, 81-90 (1959)
114. Lighthall, F., Ruebush, B., and Sarason, S. Change in mental ability as a function of test anxiety and type of mental test. *J. Consulting Psychol.*, **23**, 34-38 (1959)
115. Lipsitt, L. P. A self-concept scale for children and its relationship to the children's form of the manifest anxiety scale. *Child Development*, **29**, 463-72 (1958)
116. London, P. Developmental aspects of discrimination in relation to adjustment. *Genet. Psychol. Monographs*, **57**, 295-336 (1958)
117. Lynn, D. B. A note on sex differences in the development of masculine and feminine identification. *Psychol. Rev.*, **66**, 126-35 (1959)
118. Marshall, H. Prediction of social acceptance in community youth groups. *Child Development*, **29**, 173-84 (1958)
119. McClelland, D. C., Baldwin, A. L., Bronfenbrenner, U., and Strodbeck, F. L. *Talent and Society* (D. Van Nostrand Co., Inc., New York, N. Y., 275 pp., 1958)
120. McDavid, J., Jr. Personality and situational determinants of conformity. *J. Abnormal Social Psychol.*, **58**, 241-46 (1959)
121. Mensh, I. N., and Glidewell, J. C. Children's perceptions of relationships among their family and friends. *J. Exptl. Educ.*, **27**, 65-71 (1958)
122. Miller, D. R., and Swanson, G. E. *The Changing American Parent* (John Wiley & Sons, New York, N. Y., 302 pp., 1958)
123. Mills, J. Change in moral attitude following temptation. *J. Personality*, **26**, 517-31 (1958)
124. Milton, G. A. A factor analytic study of child-rearing behaviors. *Child Development*, **29**, 381-92 (1958)
125. Morland, J. K. Racial recognition by nursery school children in Lynchburg, Virginia. *Social Forces*, **37**, 132-37 (1958)
126. Moss, H. A., and Kagan, J. Maternal influences on early IQ scores. *Psychol. Repts.*, **4**, 655-61 (1958)
127. Nakamura, C. Y. The relationship between children's expressions of hostility and methods of discipline exercised by dominant overprotective parents. *Child Development*, **30**, 109-17 (1959)
128. Neuhaus, E. C. A personality study of asthmatic and cardiac children. *Psychosomat. Med.*, **20**, 181-86 (1958)
129. Nitsche, C. J., and Thom, W. Children's like and dislike drawings. *J. Projective Techniques*, **23**, 72 (1959)
130. Olson, W. C. *Child Development*, 2nd ed. (D. C. Heath & Company, Boston, Mass., 497 pp., 1959)

131. Palermo, D. S. Racial comparisons and additional normative data on the children's manifest anxiety scale. *Child Development*, **30**, 53-57 (1959)
132. Peck, R. F. Family patterns correlated with adolescent personality structure. *J. Abnormal Social Psychol.*, **57**, 347-50 (1958)
133. Penny, R. Age and sex differences in motivational orientation to the communicative act. *Child Development*, **29**, 163-72 (1958)
134. Perkins, H. V. Factors influencing change in children's self-concepts. *Child Development*, **29**, 221-30 (1958)
135. Perkins, H. V. Teachers' and peers' perceptions of children's self-concepts. *Child Development*, **29**, 203-20 (1958)
136. Peterson, D. R., Becker, W. C., Hellmer, L. A., Shoemaker, D. J., and Quay, H. C. Parental attitudes and child adjustment. *Child Development*, **30**, 119-30 (1959)
137. Pinneau, S. R., and Hopper, H. E. The relationship between incidence of specific gastrointestinal reactions of the infant and psychological characteristics of the mother. *J. Genet. Psychol.*, **93**, 3-13 (1958)
138. Pinneau, S. R., and Jones, H. E. Development of mental abilities. *Rev. Educ. Research*, **2**, 392-400 (1958)
139. Quay, H., and Peterson, D. R. A brief scale for juvenile delinquency. *J. Clin. Psychol.*, **14**, 139-42 (1958)
140. Rabin, A. I. Attitudes of *kibbutz* children to family and parents. *Am. J. Orthopsychiat.*, **29**, 172-79 (1959)
141. Rabin, A. I. Comparison of American and Israeli children by means of a sentence completion technique. *J. Social Psychol.*, **59**, 3-12 (1959)
142. Rabin, A. I. Infants and children under conditions of "intermittent" mothering in the *kibbutz*. (Behavior research in collective settlements in Israel). *Am. J. Orthopsychiat.*, **28**, 577-86 (1958)
143. Rabin, A. I. Some psychosexual differences between *kibbutz* and non-*kibbutz* Israeli boys. *J. Projective Techniques*, **22**, 328-32 (1958)
144. Rapaport, D. The study of *kibbutz* education and its bearing on the theory of development. (Behavior research in collective settlements in Israel). *Am. J. Orthopsychiat.*, **28**, 587-97 (1958)
145. Rheingold, H., Gewirtz, J., and Ross, H. Social conditioning of vocalizations in the infant. *J. Comp. Physiol. Psychol.*, **52**, 68-73 (1959)
146. Rosenblith, J. F. Learning by imitation in kindergarten children. *Child Development*, **30**, 69-80 (1959)
147. Rosenblum, S., and Callahan, R. J. The performance of high-grade retarded, emotionally disturbed children on the children's manifest anxiety scale and children's anxiety pictures. *J. Clin. Psychol.*, **14**, 272-75 (1958)
148. Rudel, R. G. Transposition of response to size in children. *J. Comp. Physiol. Psychol.*, **51**, 386-90 (1958)
149. Sarason, S. B., Davidson, K., Lighthall, F., and Waite, R. Rorschach behavior and performance of high and low anxious children. *Child Development*, **29**, 277-286 (1958)
150. Sarason, S. B., Davidson, K., Lighthall, F., and Waite, R. Classroom observations of high and low anxious children. *Child Development*, **29**, 287-96 (1958)
151. Sarnoff, I., Lighthall, F., Waite, R., Davidson, K., and Sarason, S. A cross-cultural study of anxiety among American and English school children. *J. Educ. Psychol.*, **49**, 129-36 (1958)

152. Sarnoff, I., Sarason, S. B., Lighthall, F., and Davidson, K. Test anxiety and the "eleven-plus" examinations. *Brit. J. Educ. Psychol.*, **29**, 9-16 (1959)
153. Schaefer, E. S., and Bell, R. Q. Development of a parental attitude research instrument. *Child Development*, **29**, 339-62 (1958)
154. Schaffer, H. R. Objective observations of personality development in early infancy. *Brit. J. Med. Psychol.*, **31**, 174-83 (1958)
155. Schutz, W. C. *FIRO: A Three-dimensional Theory of Interpersonal Behavior* (Rinehart & Company, Inc., New York, N. Y., 267 pp., 1958)
156. Sears, R. R., Maccoby, E. E., and Levin, H. *Patterns of Child Rearing* (Row, Peterson & Company, Evanston, Ill., 549 pp., 1957)
157. Seidman, J. *The Child: A Book of Readings* (Rinehart & Company, New York, N. Y., 674 pp., 1958)
158. Shakow, D. Research in child development: a case illustration of the psychologist's dilemma. *Am. J. Orthopsychiat.*, **29**, 45-59 (1959)
159. Shippee-Blum, E. M. The young rebel: self-regard and ego-idea. *J. Consulting Psychol.*, **23**, 44-50 (1959)
160. Siegel, A. E., and Kohn, L. G. Permissiveness, permission, and aggression: the effect of adult presence or absence on aggression in children's play. *Child Development*, **30**, 131-41 (1959)
161. Smith, H. T. A comparison of interview and observation measures of mother behavior. *J. Abnormal Social Psychol.*, **57**, 278-82 (1958)
162. Smith, L. M. The concurrent validity of six personality and adjustment tests for children. *Psychol. Monographs*, **72**, 30 pp. (1958)
163. Smock, C. D. Perceptual rigidity and closure phenomenon as a function of manifest anxiety in children. *Child Development*, **29**, 237-48 (1958)
164. Spiker, C. C., and White, S. H. Differential conditioning by children as a function of effort in the task. *Child Development*, **30**, 1-7 (1959)
165. Spitz, R. *No and Yes* (International Universities Press, Inc., New York, N. Y., 170 pp., 1959)
166. Spivack, G., Levine, M., and Sprigle, H. Barron M threshold values in emotionally disturbed adolescents. *J. Projective Techniques*, **22**, 446-49 (1958)
167. Staines, J. W. Symposium: The development of children's values. III. The self-picture as a factor in the classroom. *Brit. J. Educ. Psychol.*, **28**, 97-111 (1958)
168. Stendler, C. B. Possible causes of overdependency in young children. *Child Development*, **25**, 125-46 (1954)
169. Stevenson, H. W., and McBee, G. The learning of object and pattern discriminations by children. *J. Comp. Physiol. Psychol.*, **51**, 752-54 (1958)
170. Stevenson, H. W., and Stewart, E. C. A developmental study of racial awareness in young children. *Child Development*, **29**, 399-410 (1958)
171. Stevenson, H. W., and Swartz, J. D. Learning set in children as a function of intellectual level. *J. Comp. Physiol. Psychol.*, **51**, 755-57 (1958)
172. Stevenson, H. W., Weir, M. W., and Zigler, E. F. Discrimination learning in children as a function of motive-incentive conditions. *Psychol. Repts.*, **5**, 95-98 (1959)
173. Suchman, J. R. *Observation and Analysis in Child Development: A Laboratory Manual* (Harcourt, Brace & Co., New York, N. Y., 276 pp., 1959)
174. Tanner, J. M., and Inhelder, B. (Eds.) *Discussions on Child Development: A Consideration of the Biological, Psychological, and Cultural Approaches to the*

- Understanding of Human Development and Behavior*, 3 (International Universities Press, Inc., New York, N. Y., 223 pp., 1958)
175. Teahan, J. E. Future time perspective, optimism, and academic achievement. *J. Abnormal Social Psychol.*, **57**, 379-80 (1958)
 176. Terrell, G. The need for simplicity in research in child psychology. *Child Development*, **29**, 303-10 (1958)
 177. Tisza, V. B., Selverstone, B., Rosenblum, G., and Hanlon, N. Psychiatric observations of children with cleft palate. *Am. J. Orthopsychiat.*, **28**, 416-23 (1958)
 178. Trapp, E. P., and Kausler, D. H. Dominance attitudes in parents and adult avoidance behavior in young children. *Child Development*, **29**, 507-13 (1958)
 179. Trent, R. D. Anxiety and accuracy of perception of sociometric status among institutionalized delinquent boys. *J. Genet. Psychol.*, **94**, 85-91 (1959)
 180. Trent, R. D., The expressed values of institutionalized delinquent boys. *J. Genet. Psychol.*, **92**, 133-48 (1958)
 181. Vogel, W., Raymond, S., and Lazarus, R. S. Intrinsic motivation and psychological stress. *J. Abnormal Social Psychol.*, **58**, 225-33 (1959)
 182. Waite, R. R., Sarason, S. B., Lighthall, F. F., and Davidson, K. S. A study of anxiety and learning in children. *J. Abnormal Social Psychol.*, **57**, 267-70 (1958)
 183. Walters, R. H. The intelligence test performance of Maori children: a cross-cultural study. *J. Abnormal Social Psychol.*, **57**, 107-14 (1958)
 184. Walters, R. H., and Zaks, M. S. Changes in responses to a set of personality inventory items as a function of age. *J. Consulting Psychol.*, **22**, 458 (1958)
 185. Wang, J. D. The relationship between children's play interests and their mental ability. *J. Genet. Psychol.*, **93**, 119-31 (1958)
 186. Watson, R. I. *Psychology of the Child* (John Wiley & Sons, New York, N. Y., 684 pp., 1959)
 187. Wawrsaszek, F., Johnson, O. G., and Sciera, J. L. A comparison of H-T-P responses of handicapped and non-handicapped children. *J. Clin. Psychol.*, **14**, 160-62 (1958)
 188. Weir, M. W., and Stevenson, H. W. The effect of verbalization in children's learning as a function of chronological age. *Child Development*, **30**, 143-49 (1959)
 189. Wenar, C. The degree of psychological disturbance in handicapped youth. *Exceptional Children*, **25**, 7-10 (1958)
 190. Williams, W. C., The PALS Tests: a technique for children to evaluate both parents. *J. Consulting Psychol.*, **22**, 487-95 (1958)
 191. Wilson, W. C. Imitation and the learning of incidental cues by preschool children. *Child Development*, **29**, 393-98 (1958)
 192. Winder, C. L., and Kantor, R. E. Rorschach maturity scores of the mothers of schizophrenics. *J. Consulting Psychol.*, **22**, 438-40 (1958)
 193. Winograd, M. The development of the young child in a collective settlement. (Behavior research in collective settlements in Israel). *Am. J. Orthopsychiat.*, **28**, 557-62 (1958)
 194. Woodward, M. The behavior of idiots interpreted by Piaget's theory of sensorimotor development. *Brit. J. Educ. Psychol.*, **29**, 60-71 (1959)

195. Wynne, L. C., Ryckoff, I. M., Day, J., and Hirsch, S. I. Pseudo-mutuality in the family relations of schizophrenics. *Psychiatry*, 21, 205-20 (1958)
196. Zander, A., and Van Egmond, E. Relationship of intelligence and social power to the interpersonal behavior of children. *J. Educ. Psychol.*, 49, 257-68 (1958)
197. Zuk, G. H. The plasticity of the physique from early adolescence through adulthood. *J. Genet. Psychol.*, 93, 205-14 (1958)
198. Zuckerman, M., and Oltean, M. Some relationships between maternal attitude factors and authoritarianism, personality needs, psychopathology, and self-acceptance. *Child Development*, 30, 27-36 (1959)
199. Zuckerman, M., Oltean, M., and Monashkin, I. The parental attitudes of mothers of schizophrenics. *J. Consulting Psychol.*, 22, 307-10 (1958)
200. Zuckerman, M., Ribback, B. B., Monashkin, I., and Norton, J. A., Jr. Normative data and factor analysis on the parental attitude research instrument. *J. Consulting Psychol.*, 22, 165-71 (1958)

SOCIAL PSYCHOLOGY¹

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The picture of social psychology one gets from scanning a single year of research output is more a caricature than a likeness. Not only is it difficult to make a good whole out of the bits of research that happen to appear between successive Aprils, but the need for compactness inevitably brings into play the biases of the reviewer. There are distinct topics in social psychology, as there are in other fields, and, in any given year, some of them may show growth spurts. Therefore, both the material that is included and the way it is arranged reflect some compromise among logical neatness, the objective reality of the literature, and the reviewer's controvertible judgment.

As usual, not enough space was available to treat all the year's work comprehensively, so a drastic paring of the total list of references was required. Whole topics as well as individual investigations have been left out, especially in applied social psychology and those neighboring areas into which social psychologists have penetrated, such as industrial, clinical, and child psychology; economics; political science; and anthropology. There is enough to be said about the core of social psychology, meaning such topics as interpersonal relations, social influence and conformity, leadership, group structure and process, and attitudes.

INTERPERSONAL RELATIONS

Many social psychologists consider the close study of the development and change of relationships between individuals to be the heart of their subject matter. Although these phenomena have been studied for a long time, it is only recently that they have been distinctively labelled. The 1958 to 1959 season is an especially important one for interpersonal relations because of four significant books that represent virtually the total range of activity in this area.

Of major importance is Heider's treatise (46), which is concerned with theoretical analysis and conceptual clarification of naïve or "common sense" psychology and everyday experience in the hope of revealing a system of thinking about interpersonal relations that determines how individuals act toward one another. Thus, Heider analyzes relational concepts from everyday experience to arrive at a basic vocabulary for describing social situations. This vocabulary includes the ideas of: subjective environment or life-space, perceiving, experiencing or being affected by, causing, being able to, trying, wanting, belonging to, feeling (sentiments or attitudes), and ought and

¹ The survey of the literature pertaining to this review covered the period from April, 1958 to April, 1959.

² The author is currently on leave and is with the National Science Foundation.

may. Some of these relations, such as sentiment, belongingness, and causality have been explored in Heider's earlier work, but the analysis is greatly elaborated here and much is new. Throughout, Heider captures and holds in focus the essentially social aspect of interpersonal relations, primarily because the terms of his analysis are never very far from everyday experience and, thus, have intuitive plausibility. As Heider himself would be first to point out, this property is not sufficient justification for the use of a concept, but neither is sheer mathematical nor logical elegance. The test of fruitfulness lies in the experiments that Heider's ideas generate, but if this book stimulates as much empirical work as his earlier articles have, it will be a landmark in social psychology.

A second volume on the same theme is Schutz's study (113) of "Fundamental Interpersonal Relations Orientation" (from whose initials Schutz makes his title). It is also the product of a man who has been systematically concerned with relations between people and who has collected his theoretical views and empirical data into book form. But here the resemblance ends, for, while Heider's formulation is tentative, complex, and almost delicate, Schutz's is firm, simple, and strong. On the first page of his second chapter, Schutz states that: "every individual has three interpersonal needs: inclusion, control and affection; . . . (these) . . . constitute a sufficient set of areas of interpersonal behavior for the prediction and explanation of interpersonal phenomena." In support of this claim Schutz lays out a set of postulates and theorems, together with findings from a variety of psychological literature adduced as "consistent with" the theory. Schutz's principal interest is in the compatibility of members of a group and its effect on their productivity; he reports experimental findings that substantiate a positive relationship.

The papers presented at the 1957 Harvard symposium on person perception have been edited by Tagiuri & Petrullo (128). The resulting volume includes topics ranging from Ittleson & Slack's piece illustrating the continuity between person perception and object perception to Hallowell's anthropological studies of Ojibwa metaphysics, which especially emphasizes the animism of the Ojibwa and their personalization of the physical world. A number of the essays are reports of recent research on the relationship between person perception and such topics as: veridicality of liking and disliking, the perception of social preference, social influence, problem solving, group effectiveness, and cognitive matching processes. Others are theoretical or exploratory, outlining problems in psychological structure, identification, and the goal-directed basis of behavior as these are related to person perception.

Three articles fall outside this pattern. Hays outlines two mathematical models for describing relations among perceived traits. Cronbach brilliantly summarizes the mathematical and statistical problems encountered in analyzing social perception scores. His article should be required reading for anyone who is tempted to ask *X* to describe (or rate or judge) *Y*, and vice

versa, with the intention of measuring similarities in perception and/or the relation of these to other variables. The maverick essay, however, is Criswell's provocative but detached analysis of psychologists' perceptions of and relationships to their experimental subjects and to their role as scientists. She raises fundamental objections to the noncumulative nature of much psychological research and questions the wisdom of psychologists' ignoring the subject's perceptions of the experimental situation. This latter issue is truly a methodological one with endlessly complex ramifications; but it must be faced and dealt with for it surely underlies the grand strategy of research and may illuminate some of the perplexing inconsistencies and failures of experiments to replicate earlier results. Criswell's argument is relevant to much more than the area of person perception, although it has acute pertinence in that field.

A highly original fundamental contribution to the area of interpersonal relations is Schachter's monograph (111) on the affiliation motive. In a series of related experiments that develops almost like a detective story, Schachter is led from a study of social isolation to experiments on the effect of anxiety on the desire to be with other people and to the matter of individual differences in affiliative tendency. It turns out that first-born children are more affiliative. Schachter produces an astounding range of evidence from studies of alcoholism, psychotherapy, and fighter-pilot proficiency in combat to buttress this finding. His answer to the puzzle, why do men want to be together? is dual: the presence of others is directly anxiety-reducing; and the opportunity to communicate with others in the same situation allows one to satisfy a need for self-evaluation by comparing one's own response to the situation to theirs.

Tests of theory of balance.—The earlier work of Heider on the notion of "balance" in interpersonal relations was formalized by Cartwright & Harary in graph-theoretical terms (16). Now Morrisette (90) has reported several experiments testing the empirical power of this formalization. Morrisette asked his subjects to report how they would probably react to the personal relationships involved in either a co-operative rooming arrangement, a competition for a job, or a rivalrous situation. The results generally support the theory in the co-operative situation, but not in the competitive or rivalrous situations, unless one assumes that experimental manipulations were ineffective and adjusts the assumed degree of balance accordingly. Burdick & Burnes (12) report two interesting experiments that support derivations from Heider's theory of balance. These investigators found that an unbalanced state (disagreement with a liked other) was accompanied by changes in galvanic skin response and that subjects tended to change their opinions to agree with those of a liked other but changed away from him when he made himself disliked. Need affiliation also seemed to be related to opinion change among these subjects.

Impressions and perceptions of self and others.—It can be said that an interpersonal relationship begins with the perception of another and, many

would add, in relation to the perception of oneself. An abundance of work continues to accumulate on this topic. For example, Lundy (75) confirmed earlier findings that people tend to ascribe their own characteristics to people they like, especially acceptable or ideal characteristics. Two studies are concerned with psychiatric patients. McPartland & Cumming (80) found that lower-class patients have demonstrably different conceptions of self from middle-class patients, and these differences are related to behavior on the hospital ward. Dinitz, Mangus & Pasamanick (30) did not observe marked differences between patients' self-concepts and the perceptions that their families and therapists had of them. Rather, the authors conclude, the chief problem for mental patients is their difficulty in perceiving others realistically and in approaching their self-ideals.

Foa (38) has outlined a "facet" model of a dyadic relationship and applied it to an empirical study of foremen's and workers' perceptions of each other's conduct. He showed pictures of work situations to foremen and workers, asking each to indicate which of several alternative types of behavior normatively ought to occur and which actually did occur most often. Further, each worker was asked to guess which alternatives his own foreman would choose and a parallel question was asked of foremen. The four facets, then, are the actor (person who is behaving in the work situation), the observer (person giving the response), the alias (person from whose point of view the response is being given), and the level (normative or actual). Foa developed measures of closeness or contiguity among these facets and was able to show that the larger the number of contiguous facets between two variables the higher their intercorrelation. The principal substantive finding was that similarity of response depends most on contiguity in the observer facet. This is a modest finding, considering the formidable conceptual apparatus, but Foa's main purpose was to demonstrate facet theory. The power of his model may be better tested in further application.

The perception of similarity between self and others was also examined by Smith (119), who presented subjects with copies of the Study of Values partially filled out and asked them to complete the tests as they thought the starters would have. More similarity was attributed to hypothetical others who had similar rather than dissimilar scores and more additional similarity to those similar on scales on which the subject himself had a high score. As a complement to Smith's study, the research of Muraskin & Iverson (91) led to the conclusion that the greater the social distance of a particular group from a rater the more he expects the group members' social perceptions to differ from his own. This is the hypothesis of projected dissimilarity.

A topic that has been little studied is developmental changes in relationships and impressions. Two interesting studies were reported this year. Gollin (43) showed children of various ages a silent movie in which a boy appeared in scenes that connoted his behavior as both good and bad. The viewers showed distinct differences in the tendency to use inference in judging the boy's behavior, differences which were associated with age, sex,

intelligence, and social background. Danziger (24) studied the development of children's conceptions of economic relations between people. Comparing Australian children between five and eight years old, Danziger outlined four stages of development in conceptions of economic relationships. He suggested that the stages he outlined may be characteristic of the development of notions about social relationships in general.

A good deal of the research on impression-formation seems to be carried out in a vacuum without any contact between the impression and actual behavior. The research of Seeman (115) on school superintendents and heads of school districts is a welcome departure from that tradition. Seeman measured the actual mobility and the strength of his subjects' interest in status and advancement, classifying the subjects into four types on these two variables. He also collected descriptions of each subject's behavior from his staff and from his board members, discovering that the subject's typological position was clearly related to the behavioral description. In short, how the superintendent feels and acts about his career is related to how he is perceived as behaving by others, and to how he will perceive his own behavior.

Evaluation of own and others' behavior.—Those who believe that men are capable of taking an objective view of themselves will draw some comfort from an experiment by Howard & Berkowitz (57), but will draw less from Gerard's results (39). Howard & Berkowitz showed that, in general, the response of a subject to evaluation of his performance will depend upon his level of aspiration, his desire for accurate evaluation, his need for self-enhancement, and the unanimity of his evaluators. The most striking finding was that when a subject must depend upon other people for evaluation of his performance he rejects deviant judgments, whether these be self-enhancing or not. Thus, a single disagreeing judge's opinion is less accepted than a consensus of observers, even if the latter presents an unflattering evaluation. On the other hand, Gerard observed that when participants in a discussion believed they would be graded on their performance they were relatively inaccurate judges, tending to overrate both their own contributions and others' opinions of them. Under conditions of low motivation, subjects made more accurate judgments.

Talland (129) did not find significant differences between men and women in accuracy of judging their status in a group, nor did he find that leaders or others ranked highest in a group were better judges of sociometric ratings than less highly ranked people. On the other hand, Bugental & Lehner (11) came to a slightly different conclusion. They distinguished between leaders (who take a group toward its goals) and "populars," and found that populars are indeed more accurate perceivers of the popularity of others than are leaders. However, populars are not different from leaders in perception of leadership or in accuracy of self-perception on personality variables. The question of relative accuracy or sensitivity of leaders and others still needs some cleaning up.

A further aspect of the judgment of others involves what Jones & de-

Charms (64) call "inferential sets." The authors induced one of three sets in a group of naval air cadets by assigning them three different roles in listening to a tape-recorded interview with an alleged ex-prisoner-of-war. In one treatment, the subjects were asked to suppose that they were members of a medical psychological board (the causal-genetic set); in another, that they were members of a court of inquiry (situation-matching set); and in a third, that they were simply soldiers trying to decide whether the stimulus person would be a good friend (value-maintenance set). The various sets aroused had distinct, if unexpected, effects on the perception and evaluation of the stimulus person. Among the several findings was one of particular interest. Contrary to expectation, the subjects acting as a court of inquiry evaluated a stronger, better adjusted version of the stimulus person as less likeable, less patriotic, and more opportunistic than the weaker, less well-adjusted version, even though the two had performed the same acts, such as signing propaganda documents. The authors suggest the idea of responsibility as the crucial intervening element in the chain of evaluative reasoning leading to this conclusion.

A particularly interesting derivation from Heider's notions about causality and the attribution of a cause for another's behavior was tested in a study by Strickland (126). He proposes that close surveillance of a subordinate may lead the supervisor to place the locus of causality for the worker's behavior in the supervisor rather than in the worker. Strickland's experiment involved a subject acting as a supervisor who could monitor the work of one worker very closely and another hardly at all. The supervisor's job was to get a high output on a rather dull task. Both workers performed equally well but the more closely supervised one turned out to be less trusted, was seen as less dependable, and was chosen for surveillance again on a second series of trials. Finally, there was tendency for this worker to be seen as complying because of the surveillance applied by the supervisor whereas the less closely watched worker was seen as complying because he "wanted to" or was a "nice guy."

Determinants of sociometric choice.—The very important question of whether those who are alike in personality characteristics prefer each other was enlightened by the study of Hoffman (50), who reported a primary negative finding and some additional evidence. He composed work groups either homogeneous or heterogeneous in members' personality profiles on the Guilford-Zimmerman Temperament Survey and, after the groups had worked together all semester, examined the ratio of in-group to out-group choices. The differences between the two types of groups were not significant, thus casting doubt on the assertion that similarity determines attractiveness. Rather, Hoffman feels, attractiveness of fellow members depends upon the success of the group in solving its problems, which differ in homogeneous and heterogeneous groups. (In this study, the homogeneous groups had greater difficulty in accomplishing their assigned tasks, the heterogeneous

groups in regulating their internal relations.) The data he reports in support of this conclusion are not conclusive, but are strongly suggestive.

An interesting rapprochement between sociometry and Lewinian field-theory was proposed by Bjerstedt (8), who attempted to account for some of his findings on the stability of choices and rejections in force-field terms. Among other things, he demonstrated the greater stability of symmetrical (vs. asymmetrical) and stronger (vs. weaker) relations over time, suggesting that inferred forces toward locomotion can account for these findings. Clearly these theoretical ideas are in elementary form, but the findings are consistent with earlier ones and with the suggested conceptualization.

Four studies examined the racial composition of groups as a determinant of choice. Berkun & Meeland (6) studied combat troops, while Cox & Krumbolz (23) surveyed airmen in training. Two studies by Mann (81, 82) found that both sociometric choices and perceptions were influenced by the racial composition of the group, and influenced differently depending on whether the chooser was with a majority or a minority of his own race.

SOCIAL INFLUENCE AND CONFORMITY

It is quite apparent that there has been no waning of interest in the ways in which members of groups influence each other to make decisions, change opinions, make judgments, sign documents, or perform a variety of other tasks experimenters contrive. Research on these topics received a tremendous impetus during the early Fifties from the experiments conducted at the Research Center for Group Dynamics on the determinants of conformity and the consequences of deviation from group standards or modal behavior. It is perhaps surprising to find that a few of the original questions raised by this group are still receiving experimental attention, although the bulk of the work is now on new problems.

Determinants of conformity. An example of the persistence of an early problem is found in the work of Downing (32), who failed to replicate the often repeated finding that highly cohesive groups are more able to influence their members than less cohesive ones. Downing attempted to induce conformity to group estimates of autokinetic movement, but found no significant differences between high and low cohesive groups. Downing feels that the relationship between cohesiveness and susceptibility to influence may hold only where cultural values sanction such influence. In another study, Berkowitz & Howard (5) reaffirmed an early finding that initial communication in group discussion would be directed toward those who deviated from the modal opinion. The authors also found that high interdependence among members is associated with increase in volume of communication to the deviate and with tendency to reject him when he resists influence. An attempt to elaborate conformity-pressure theory by assessing the effects of variations in affiliative needs was less successful in this experiment, apparently because of the overriding effect of the interdependence variable.

The tendency to add new dimensions to a familiar experimental procedure, mentioned in connection with the Berkowitz & Howard study, is a healthy one, for, in general, this procedure leads to refinement and extension of theories, enabling more variation in behavior to be explained and requiring less dependence on the familiar caveat "other things being equal." Presumably, the increasing complexity of many-variable experiments could lead to closer approximation of reality in the laboratory, although the demands on the experimenter's ability to measure or control, time and number of subjects required, and the strain imposed on present methods of analysis may set some upper limit on the amount of complexity that can be managed. A further constraint is the difficulty in reporting complex experiments clearly and compactly for any but a completely "in-group" audience.

An example of the complicating of a familiar experiment is provided by Jackson & Saltzstein (60), who attempted to vary motivation to conform to group judgments by manipulating three variables: attractiveness of the group, acceptance of the member by the group, and the extent of member interdependence. The first two variables receive further consideration in a separate theoretical article by Jackson (59) describing a general typology of relationships between persons and groups. The results support the assertion that conformity is related to interdependence and, for the highly accepted subjects, to attractiveness. One interesting sidelight is the apparent interaction between acceptance by the group and attraction to it, which probably weakened the differences obtained.

Ever since Asch's report of his experiments on conformity to group judgment about stimuli of little ambiguity (1), psychologists have been trying to come to terms with the apparently hard-to-believe possibility that social reality may be more convincing than sensory reality. One attempt at explanation distinguishes "task orientation" from "group orientation"; e.g., whether the subject attends to what is said in a message or to who is saying it. Some experimenters feel that these two orientations are rooted in personality characteristics. For example, McDavid (79) classified his subjects by means of a sentence completion test as "message oriented" or "source oriented." In a test of yielding to or resisting majority opinion in the task of counting metronome clicks played to them over a set of phones, the source-oriented subjects not only yielded more often to majority opinion but tended to agree with it rather than to compromise. They yielded just as often when the task was easy as when it was difficult and they yielded more when the discrepancy between majority opinion and their own was greater. McDavid concluded that these subjects were motivated to conform in order to avoid being different. The "message oriented" subjects behaved in opposite fashion and appeared to yield when the information in the message increased their own success. The two types of subjects did not differ in self-esteem, but the source-oriented subjects were more ready to modify their perceptions of themselves in response to interpersonal communication. A complementary finding was obtained by Schroder & Hunt (112), using McDavid's task. The

authors separated their subjects by means of a paper-and-pencil test into self-devaluators and nondevaluators. The former yielded more often to majority opinion, but this personality factor did not discriminate yielding on small, as compared to large, discrepancies. In a second experiment, Schroder & Hunt, assuming that subjects who tend to yield at high discrepancies from veridicality are source-oriented, showed that these subjects, more than message-oriented subjects, tended to weight the source of a remark according to the attractiveness of its maker. That is, they were more responsive to influence from attractive than unattractive others.

An interesting comparison with the foregoing experiments is provided by Jones, Wells & Torrey (66), who studied the effect of feedback from experimenter to subject under a variety of conditions. The subjects were given a task in which sensory evidence conflicted with group judgment. When the Ss were "group oriented" by instructions and were told they could be evaluated by their partners, the reinforcement of conformity by the experimenter had a stronger effect than the reinforcement of independence. But when no "group orientation" was induced, experimenter feedback supporting independence from group judgment was more effective than "pro-consensus" feedback. As these investigators note, the results of this experiment look remarkably like the results obtained by Asch when the naive subject was given a partner who agreed with him against the majority.

Other determinants of yielding to influence were reported in several studies. Coleman, Blake & Mouton (19) found that conformity pressures were more effective when subjects were less adequately informed about the possible correctness of responses. Using a "test of general information" whose items were graded in difficulty and relative familiarity, these investigators found that difficulty and frequency of conformity were positively correlated. Goldberg & Lubin (41) demonstrated on a perceptual task that the amount of influence the subject would accept was a function of the amount of error he believed he had made in previous judgments.

Although it is not clear whether a study by Nakamura (93) bears upon determinants or upon consequences of conformity, it is worth noting that this author observed a negative relationship between conformity in Asch's situation (1) and achievement in a problem-solving task, when measured intelligence was partialled out. This relationship held for the men, but not the women, in his sample and was stronger for older men and on problems that demanded a change in the subject's initial approach in order to achieve a solution.

Helson, Blake & Mouton (48) have summarized the interaction between situational and personal factors as these affect willingness to sign a petition. When the situational factors are all positive or all negative, the decision is determined for almost all individuals, but when some situational factors are positive and some negative, then submissiveness or conforming tendency seems determinative. Finally, Steiner & Peters (123) observed that tendency to conform to the judgments of an accomplice of the experimenter is related

to assumed similarity (ASo). Nonconformers rejected the accomplice, devalued the importance of accuracy in their judgments, or recalled fewer disagreements with the accomplice than had occurred. All of these findings seemed to Steiner & Peters to be consistent with Newcomb's A-B-X theory (94).

Public and private commitment.—A particularly interesting variable bearing upon the effectiveness of social influence is the degree to which an individual's decision or opinion must be made public or can be kept private. Several experiments report evidence on different aspects of this problem. Mischel (89) studied a level of aspiration situation in which the subject, following failure, was offered another opportunity to try the task. Subjects were more likely to lower their estimates of their next scores if the first one had been private than if it had been public. Mischel tried several variations of the "public" situation, concluding that the essential characteristic of it is direct face-to-face statement to another person. Smith (120) studied resistance and either overt or covert yielding to a request. Under one condition the subject could resist overtly by saying aloud what he would do; under another, he could indicate his decision silently. Smith found that yielding was much more likely to occur in the overt condition, and to occur early in the series of trials, since, presumably, the decision not to yield had the effect of a public commitment. An incidental finding was the occurrence of appreciable autonomic disturbance on the part of nonyielders in the covert condition compared with relatively little such disturbance in the overt groups, where early decisions ended the conflict.

Both of the foregoing experiments support the view that making one's stand public tends to make it more resistant to change. The investigation of Raven (102) shows that subjects who were led to believe that their opinions deviated from the majority of the group were more likely to change their views if they thought they were to become public than if they believed they would remain private. This finding holds except for the extreme deviants who were likely to hold on to their opinions anyway. While these findings are all reasonable, there does not seem to be an adequate theoretical explanation of the effectiveness of public commitment. Mischel contends that, under conditions of public commitment, 'the subject can expect admission of failure to lead to negative reinforcement from others as well as from himself. Raven suggests and adduces some evidence to support the view that the possibility of rejection by the group results in greater conformity under public than under private conditions, which seems to be another way of saying about what Mischel had in mind. The basic notion here seems to revolve around avoiding loss of face, but the phenomenon has not been fully explored in conceptual terms.

The variable of commitment to a position continued to be explored by Festinger and his associates. One of the derivations from Festinger's theory of dissonance (35) is that when a person is forced to do or say something discordant with his privately held opinion there will be a tendency for that

opinion to change in such a way as to bring it into correspondence with the act performed. A second and more subtle derivation is that the greater the pressure used to induce the discordant act the smaller will be the tendency to change opinion. An ingenious experiment by Festinger & Carlsmith (36) put subjects in a boring situation after which they were offered varying amounts of money to try to persuade others (presumably prospective subjects for the same situation) that the experience had been interesting and exciting. The results substantiate both derivations. Another derivation from dissonance theory was explored by Mills (86). He investigated changes in moral attitudes following either cheating on a test or refraining from cheating. Reasoning that, whichever of these choices is taken, there will be some residual dissonance between the chosen alternative and the advantages of its opposite, Mills predicted and found that those who did not cheat became more severe in their attitudes toward cheating while those who did cheat became more lenient. Both maneuvers reduced residual dissonance. Furthermore, the greater the motivation to cheat, the greater were these effects. Finally, it is gratifying to note that Cohen, Brehm & Latané (18) replicated one of Festinger's dissonance experiments (35) with strongly supportive results and some new information. Gratification is appropriate here both because carefully conducted replications are too infrequent in social psychology and because the relationship originally reported by Festinger was a complex curvilinear one between amount of dissonance and tendency to seek or avoid information. The replication also showed that the relationship was intensified when the subject expected that his choice of strategy and his success would be publicized.

LEADERSHIP AND POWER

As Cartwright points out in the first essay of the series on social power that he has edited (15), power is a greatly neglected variable in experimental research on influence and conformity. He argues persuasively that the ordinary concepts of group psychology—communication, role, norm, and the like—cannot account for influence, change, and resistance to change unless power of the individuals over each other is also taken into account. The 10 studies published here for the first time are the products of work done by members of the Research Center for Group Dynamics over the past eight years. The studies include reports of experimental and field investigations as well as theoretical essays that attempt to specify properties of the concept "power," principally in terms of potential performance, control of resources, and motives of the persons involved in a relationship.

Experimental research on the power variable in leadership behavior also showed a growth spurt. Raven & French (103, 104) conducted two quite similar experiments comparing response to a supervisor whose position had been legitimized by election with one who had simply taken over from the legitimate leader. While they found that the elected leader was seen as having a greater right to her office and was more attractive, in neither experiment

did they find a significant difference in the acceptance of the supervisor's instructions to slow-down the amount of work turned out. Raven & French feel that the absence of a difference may be due to "overconformity" on the part of workers under the illegitimate supervisor in order to express their disagreement with her orders. Perhaps so; or perhaps the rather dull and unrewarding task of cutting out pieces of cardboard at one cent per piece offered too little motivation for resisting orders to slow down. In one of these experiments (104), the supervisor in half the groups had coercive power (i.e., she could levy a fine); it is interesting to note that coercive power reduced the perceived attractiveness of the supervisor but not agreement with her evaluations of work nor perception of the legitimacy of her position.

Both of these experiments cry for comparison with the earlier finding of Borg (9) on the relative effectiveness of spontaneous and designated leaders. Borg found that designation of someone who had not emerged spontaneously as a leader did not improve this person's performance, but did reduce the effectiveness of the spontaneous leader. This finding seems to be a complement of that obtained by Raven & French. Both of these findings shed some doubt on the notion of legitimacy of authority. Perhaps legitimacy is less important in groups in which motivations are relatively weak. This interesting area will bear further research and it is to be hoped that somewhat more powerful experimental situations can be contrived.

The exercise of power by a leader was investigated by Kipnis (69), who compared the effectiveness of two styles of leadership, coupled with reward or punishment, on both public compliance with and private acceptance of an attempt to influence a preference. Both reward and punishment were equally effective in producing public compliance. In private acceptance, however, an interesting difference was obtained. Participative leadership was more effective than directive leadership in both the reward and in the control group, but less effective in a punishment group. The investigator suggests that under participative punitive conditions members get support from each other for resisting the leader's power, but there is no such opportunity in the directive treatment.

An attack on some central problems in leadership is well reported in Fiedler's summary (37) of six years of research on interpersonal relations and group effectiveness. Most of this research was developed around the variable of perceived similarity among group members, and a considerable effort went into developing the now familiar ASo (assumed similarity between opposites), a measure of the perceived difference between the persons with whom one works best and least well. The general finding, that the most effective groups are those in which the leader maintains some psychological distance from his followers, is subject to qualification depending on the personal qualities of the leader and his subordinates' acceptance of him.

In other studies of leadership, Bass *et al.* (3) found that attempts to lead during a leaderless group discussion were positively related to motivation to do well at the task and the amount of control or power arbitrarily assigned

to the individual by the experimenter. On the other hand, Pepinsky, Hemphill & Shevitz (98) found that generalized motivation to achieve was not associated with attempts to lead a group in the face of personal rejection from fellow members (experimenter's accomplices). Instead, approval of leadership attempts as well as compliance with them by group members resulted in many more attempts to lead than did the rejection condition. These investigators also observed that morale was higher in the acceptance condition, but productivity was qualitatively better when subjects experienced rejection of their attempts to lead. The authors point out that other experiments have found morale to be higher in warmer or more accepting climates, but that productivity is often no better or even worse.

A careful validation study of role playing tests as predictors of performance in officer candidate schools is reported by Tupes, Carp & Borg (131). The authors conclude that scores obtained from role-playing situations are significantly and positively correlated with the criteria of effectiveness, but are too low to permit successful prediction.

One of the problems that has perplexed students of leadership has been the extent to which the leader of a group does or must conform to its norms or values. The investigation of Kates & Mahone (67) substantiates a weak relationship between leaders' values and those of the group. Yet, as Hollander (51) has pointed out, there is a paradox here. Although status presumably is related to conformity to norms, leaders who are of high status in a group are able to direct and change these norms. Hollander has tried to explain the paradox by employing the notion of "idiosyncrasy credit," a kind of accounting scheme in which an individual accumulates credits by conforming to norms, demonstrating competence in group activities, having high status outside of the group, and by being a pleasant and convivial fellow. These credits can be spent in "idiosyncratic" behavior, including deviation from expectancies and innovation. Hollander's analysis is stimulating and will probably suggest some experimentation.

GROUP STRUCTURE AND PROCESS

Interaction and its measurement.—The technique for studying human interaction originally suggested by Chapple & Arensberg (17a) has recently been the subject of considerable interest to social psychologists. Matarazzo *et al.*, (83) have used the standardized interviewer performance technique that Chapple developed for employment interviews and applied it to the study of hospital patients. The authors' analysis in terms of number and duration of acts, number of initiations, interruptions, and overridings show that there are wide differences between individuals, but that intraindividual rates are remarkably stable over time. Guze & Mensh (44), on the other hand, present data that question the adequacy of the first 10 minutes of the Chapple standard interview as a baseline for comparison with behavior during other intervals in which different kinds of activities are going on. They allowed the initial nondirective period to run for 30 minutes, finding rather

large intraindividual variation in number and duration of actions between the three successive 10-minute periods. They conceded, however, that any given individual may act very much the same during the first 10 minutes of an interview on repeated occasions. What seems to be missing here is some adequate notion of what is meant by stabilized or representative behavior. Surely something like fatigue or boredom with the nondirective interview must appear sooner or later, and there seems to be no rationale for choosing any particular length of time as representative or stable.

In a rather different vein, Miller (85) has criticized the distinction Chapple makes between "originations" of action and responses to origination. Miller's research on teams of glassblowers convinced him that there were many occasions when team members responded simultaneously or jointly to cues implicit in the work situation rather than to any person's origination. He terms these "situational interactions" and argues that if they are forced to fit the traditional categories of originations and responses, they blur otherwise clear differences.

Virtually every phase of interaction in 10-person groups was studied by Borgatta, Cottrell & Mann (10), who collected trait, behavioral rating, and sociometric data and scored the interactions of their groups by Bales' method. Their primary purpose was to test Carter's (14) earlier finding that three factors account for most of the variance in individual interaction: individual prominence and achievement, aiding attainment by the group, and sociability. Their factor analysis produced three factors which correspond fairly well to Carter's (although two are renamed) and two additional factors entitled "manifest emotionality" and "task interest," which increase the amount of variance explained. In addition, choice, behavioral rating, and social perception data are explored in relation to interaction measures.

Finally, a long-time student of social interaction has taken a fresh look at some of his own ideas and wants to recast them. Homans (53), continuing his search for a set of general principles that will relate experimental and field research on small groups to a set of general propositions, suggests in an expository paper that it might be useful to look at social interaction in terms of rewards and costs. He puts forward several tentative propositions relating to profit, cost, and value of social behavior and analyzes some earlier studies to show how the dynamics of exchange can generate group structures.

Group structure.—Social structure is one of the traditional areas of sociology and it is not surprising to find sociologically trained social psychologists contributing substantially to research on social structure in small groups. Mills (87) has reviewed and summarized a number of remarks by Simmel on such topics as the forms of play, games, and other instances of "sociability." Mills reduces to fairly succinct terms a number of assertions that Simmel made about dyads as compared to triads and large social systems, suggesting some general schemes for empirical testing. Mills and his associates (88) have also reported an experimental study of some of Simmel's propositions about newcomers to a group. Simmel's influence is also reflected in the work

of Caplow (13), who presently elaborates his original analysis of coalitions in the triad by adding two new types of triads and distinguishing three types of situations in which coalition formation may occur: continuous, episodic, and terminal. These distinctions between types of situations force the modification of one of the assumptions incorporated in the earlier version of the theory and result in some new derivations about most likely coalitions. Caplow also presents some evidence from empirical studies including an investigation of sibling triads where, apparently, his theory of coalition formation does not hold.

Until rather recently, survey research was concerned with individual behavior and tended to neglect the social relations among individuals, or, at best, to view them solely through the responses of the individual respondent. Now, as Coleman points out in a broadly descriptive article (20), all this is changing and there have been developed some designs and techniques that can be used to collect sociometric-like data on large aggregates for the purpose of determining patterns of relationship or social structures. Coleman describes four sampling designs and corresponding analytic techniques for getting data on such problems as the relation between the characteristics of a respondent and those of his social environment, the degree of homogeneity of attitudes in a large group, similarities between pairs of friends or co-workers, and the partitioning of large groups into cliques. It is notable that computers play an important role in these analytic procedures—surely a sign of the times and very likely an indication of an important trend in social psychology.

The influence of technology on social organization is well developed in two papers. Downs (33) has analyzed two problems of managing routines aboard a naval vessel which he believes were grossly complicated by the changes in the status system resulting from alterations in naval technology. The consequent changes in prestige and importance of particular occupational specialties found expression in contests for privilege in messing and going on liberty. Faunce (34) studied an automated production line in the automobile industry. He notes that such factors as the greater distance between work stations, fewer jobs involving teamwork, and operator-controlled work pace all contribute to reducing the opportunity for men to interact on the job. As Faunce also points out, automation seems to eliminate or radically change opportunities for the study in industry of such problems as the effect of leadership on productivity and the cohesiveness of work groups.

Some of the essays in a collection that describes the contemporary state of sociology (84) are relevant to social psychology. Bales presents some interesting speculations on what he terms "naturalistic prediction" of the behavior of a member of a group. He attempts to imagine the process and the various influences that have to be considered in order to predict interpersonal behavior, suggesting that simulation of the process by a computer may be a good way of developing such ideas. Newcomb's article is a synthesis of some of his findings from a study of group formation, cast in terms of his

theory of strain toward symmetry in interpersonal relations. The third piece that is relevant to social psychology is Inkeles' essay presenting a sociological perspective on the study of social structure and personality; it delineates a number of problems in which consideration of personal factors will illuminate social behavior.

The concepts "role" and "status" have been both stand-bys and stumbling blocks in research on social structure. The latter concept engages Harary (45), who presents a graph-theoretical, mathematically formal scheme for determining the status of an individual in an organization. He introduces the term "contrastatus" to describe the amount of superordination an individual in an organization can experience, reserving the term status to mean the weighted number of subordinates of an individual. Some of Harary's derivations are provocative, but it remains to be seen whether this mathematical tree will bear social psychological fruit.

On the other hand, Levinson (72) considers the concept "role" to be "the most overworked and underdeveloped concept in the social sciences." He distinguishes three meanings of role: structurally given demands, a member's conception of the part he plays, and a member's actions in relation to the norms of the group. Levinson feels that failure to keep these three meanings distinct is responsible for much of the confusion he finds in the current literature.

Levinson need have no complaint about the conceptual clarity of the research by Videbeck & Bates (132), who, employing Levinson's second meaning of role, report a study of five relatively long-lived small groups. The authors show that intensity of role expectations is related to the perceived performance of members. Since the same subjects rated both role expectations and role performance, there is obviously a possibility of spurious correlation, but Videbeck & Bates feel that it is minimized in their procedure.

Finally, Slater (118) reports that the magic number in group size is five. He asked members of task groups from sizes two through seven to tell him whether their groups were too large or too small. It turned out that five was not too anything. Slater argues that in larger groups there is increased "psychological freedom" because of lessened fear of alienating other members. But, simultaneously, problems of organization and communication increase, which means a decrease in "physical freedom." Five members is the size at which both physical and psychological freedoms are optimal.

Social factors in psychotherapy.—Although there are obvious meeting grounds for social and clinical psychologists in the area of group psychotherapy, co-operation, especially at the conceptual level, has been the exception rather than the rule. Some beginnings in this direction are a discussion by Stock, Whitman & Lieberman (124) of the concept of deviance as it applies to therapy groups and an analysis by Beck (4) of group therapy in terms of roles, patterns of interaction, and group norms.

On the empirical side, there were three investigations of patients' behavior. Murray & Cohen (92) found in a study of a mental hospital that com-

plexity of social organization decreased as degree of mental illness increased and that the form of therapy was related to the type of social organization prevailing in schizophrenic wards. A study by Parker (96) of a psychiatric ward in a British social rehabilitation unit suggested that patient behavior and relationships with staff may have been related to the distribution of leadership functions. The third investigation, by Palmore, Lennard & Hendin (95) concerned communication patterns between patients and therapists during sessions of individual psychotherapy distributed over four months. The authors found that, as therapy proceeded, the verbal behavior of patient and therapist became more alike; they believe that the sensitivity of patients and therapists changed symmetrically.

Finally, Hollingshead & Redlich (52) have pulled together the results of their research on the relationship between mental illness and social class. The report presents a full discussion of the research design as well as their findings that mental illness is differentially distributed among the various social classes and that the form of treatment a patient is likely to receive is, equally, related to his social status. This pioneering inquiry raises fundamental questions, both technical ones about the nature of psychotherapy and broader ones about our present society.

Relationship between individual and group.—Stotland (125) proposed and offered evidence to support the views that members will be more attracted to a group if it achieves the goals set for it while they are in the group than if it does not achieve these goals; and that persons with low self-esteem will be less attracted to a group when all members have failed than will be persons with high self-esteem. Zander (136) reviewed a number of studies of group membership and individual behavior, concentrating on the factors of hostility or warmth in personal relationships and self respect as determined by feelings of failure and identification with the group. In a discursive analysis of interaction, Watson (133) distinguished three types of relationship between the individual and group: work oriented, familial, and sociable. She points out that a great deal of group research deals only with work-oriented groups. Thus, the social-psychological picture of collective life may be distorted.

Group performance.—A review of research comparing group and individual performance has been published by Lorge *et al.* (73). Their review includes studies of judgment, learning, social facilitation, problem solving, productivity, and memory. Unfortunately, it covers much the same ground as did the work by Kelley & Thibaut (68), adding only about 10 items that have appeared since they published. If they draw any conclusion at all, Lorge *et al.* are unhappy with the tendency in social psychological research to "treat the *ad hoc* group solving a trivial task as a prototype of a fully traditioned group solving a very important problem." Since they do not make a very convincing case for the importance of the difference between "*ad hoc*" and "*traditioned*" groups, their arguments lack force.

An interesting and well-designed study of group performance compared

to that of individuals is reported by Barnlund (2). The author compared individuals working alone, hypothetical groups constructed by pooling, and actual groups trying to solve syllogistic problems by discussion. In general, Barnlund found that decisions of the average actual group were superior to those of the average individual. Furthermore, those of actual groups were superior to majority decisions reached in constructed groups. Whether the majority decision in a constructed group is equal to or better than the decision of an individual working alone depends upon how deadlocks are resolved, but Barnlund concludes that the majority is, in general, no better than the average individual. Barnlund suggests two reasons why actual groups did not turn in perfect performances: first, on some problems groups went to immediate and unanimous agreement on a wrong solution, apparently substituting agreement for analysis as a criterion of success; second, some groups could not resolve a conflict between two members or two parties except by giving in or compromising on a wrong solution, presumably to prevent loss of face.

That the effectiveness of a group in solving problems is improved by feedback of correct information is illustrated in an experiment by Pryer & Bass (99). In groups that were told the correct answer after they had made both individual and group judgments, the initial accuracy of subjects' rankings on the next problem did not improve, but the group decision on this next problem was more accurate than it was when no feedback was given. The authors conclude that feedback stimulated learning how to approach the problem and generated an interest in the task.

How two people learn to perform correctly an act that is some joint function of the individual behavior of each and what the effect of knowledge of results is upon their behavior are questions that have been scarcely touched by social psychologists. A beginning in this direction is the experiment of Rosenberg & Hall (109), who compared the effects of different types of feedback about performance in dyadic teams. Two subjects having no knowledge as to how each other's performance might be related were given the same pointer-setting task and, on all trials, were told either (a) own error (b) "teammate's" error, or (c) a "confounded" measure: the average of own and teammate's error. Rosenberg & Hall's general finding was that learning was greatest when the individual was told his own error only, poorest when told only his teammate's error. This general problem needs much further research, though one may question the strategy of leaving the subject completely in the dark about the interactive conditions under which he is performing.

A number of interesting studies of the effect of group composition on productivity almost miraculously arrived at the same general conclusion, that heterogeneity of membership produces superior results to homogeneity. This finding holds in the research done by Hoffman (49) on groups heterogeneous in member personality profile and in the research by Ghiselli &

Lodahl (40) who studied the relationship between amount and carefulness of work done and a measure of the distribution of managerial skills, such as supervisory ability and style of decision making. These investigators found that in groups in which one member made an extreme score while the rest were homogeneous, a greater amount of work was performed. Finally, Ziller & Exline (137) report a study showing that those groups of males which were heterogeneous in age (the range was from early 20s to mid 60s) were more accurate in estimation and judgment tasks than groups homogeneous in age. (This finding, sadly, does not hold for female groups, thus spoiling what was beginning to look like a perfect batting average on this problem.) In general, the explanations offered for the superiority of heterogeneous groups draw upon the factor of variety. Ziller & Exline, however, argue that in newly formed groups, age heterogeneity produces a stable status hierarchy which, they feel, is favorable to productivity. It is worthwhile pointing out that, in the two studies where it was measured, members' satisfaction did not co-vary with degree of heterogeneity or homogeneity.

Some kinds of heterogeneity are inevitable in a group but may not be helpful. For example, Riecken (107) observed that, in groups in which the most talkative member had the superior solution to a problem, he could get it accepted by other members, whereas, when the same solution was in the hands of the least talkative member, he usually failed to gain acceptance for it.

The relative effectiveness of co-operation and competition may depend, as Shaw (117) points out, on either motivation or on procedural arrangements. By keeping the procedural arrangements the same for both competitive and co-operative conditions, Shaw is able to argue that the greater efficiency of subjects who believed they were co-operating was due to the arousal of less disruptive levels of motivation (and hence less interference with performance) than was the case for competitively motivated subjects.

The desire to belong to a group (membership motivation) and willingness to work for group goals (achievement motivation) are related, Deutsch argued (28), but the relationship may be fairly complex. For example, he found membership motivation to be strong when a member perceived his group as capable, with a good chance of winning a prize, and believed the other members wanted to belong to the group. But Deutsch expected somewhat different relationships with achievement motivation: high-capability, highly motivated groups would show more achievement motivation when the probability of success was low; but low-capability, weakly motivated groups would show more achievement motivation when probability of success was high. The rationale is straightforward: it's just as exciting for a bunch of dubbers to sail around the harbor as it is for an experienced crew to enter an ocean race. Deutsch obtained some support for the hypothesis about achievement motivation, although the findings are not altogether consistent, perhaps because of unintended interaction between independent variables.

CROSS-CULTURAL STUDIES

Social psychology has very often been accused of parochialism in failing to take sufficient account of cultural variation in social behavior. The criticism is probably justified and it is encouraging to see a few pieces of research that attempt to test methods or hypotheses outside of strictly white, middle-class U. S. settings.

An interesting attack on the question of cross-cultural comparability was made by Lovaas (74), who used a translated version of Edwards' Personal Preference Schedule to measure the correspondence of social desirability judgments between Norwegian and American college students. He found a correlation of .78, which, he points out, may be an underestimate because of translation errors. On the whole, Americans rate as more desirable such factors as order, intraception, and abasement. Norwegians rate aggression more desirable than Americans. This latter finding is echoed in a similar study by Klett & Yaukey (70), who also used the Edwards Schedule. Their comparisons involved, in addition to Americans, some Near East students from the American University in Beirut, a Nisei group, and a Norwegian group. They report intercorrelations ranging from .74 to .96. Considering the apparent diversity of cultures involved, one may well be surprised at the size of these correlations.

The effect of cultural contact and change upon the attitudes, beliefs, and ideas of members of society can be studied by psychological methods, usually those of a projective type. Thus, DeVos & Miner (29) analyzed Rorschach protocols from Algerian rural and urban men, finding differences between these two groups and relationships between personality factors and cultural beliefs. An intelligent discussion of methods for and problems encountered in the study of attitudes of Africans is presented by Biesheuvel (7) who also provides details of a promising inventory designed to measure attitudes towards Western customs and ethical and legal concepts.

An interesting insight into the *Weltanschauung* of the presently dominant and subordinate races in South Africa is provided by Danziger (26). He compared the aspirations of white and nonwhite (both Bantu and Indian) students at university and technical schools in Natal. The students wrote autobiographical essays and answered questions about their aspirations. He found that nonwhites tended to emphasize political values and specific goals for the society as a whole. Whites, however, were oriented toward private satisfactions such as career success and the cultivation of personal qualities. For the nonwhites, personal and sociopolitical goals were integrated. Further analysis of responses (25) showed that nonwhites tended to explain this difference in terms of economic factors and conflict between groups.

A limited number of social psychologists seem to be concerned with developmental problems viewed cross-culturally. Jahoda has reviewed the cross-cultural research on child animism (61) and reports a study of his own carried out with children in Accra (62) where he also investigated the notion of "immanent justice" among children in this society (63). Knapen (71)

studied the effects of child training practices on the development of personality among the Baconggo. Rabin (100) administered sentence completion tests to Israeli and American ten-year-old children. His findings led him to emphasize differences rather than similarities between the two countries and the greater continuity between child and adult roles in the Israeli society.

In a few cross-cultural studies we have an opportunity to see ourselves as others see us. For example, Zaidi & Ahmed (135), using the classical technique of the checklist of favorable and unfavorable adjectives, surveyed stereotypes concerning nine foreign nationality groups among students at Dacca University in Pakistan. Americans finished third, behind the Turks and Chinese but well ahead of the French and British, who, in turn, led only the Indians. On the other side of the border, Rath & Das (101) studied the stereotyped attitudes of residents of Orissa, India, towards Americans, British, Russians, and Chinese, again by an adjective check-list. Again, Americans finished in third place behind Chinese and Russians.

In closing this section, it is appropriate to mention the finding of McClintock & Davis (77) that the less important a foreign student considers his nationality to be in his own concept of himself, the more likely he is to be satisfied with his sojourn in the United States, to have favorable attitudes towards this country, and to be less closely identified with his home country—a significant note indeed in an era of eruptive nationalism.

ATTITUDES

The study of attitudes, their change, and their correlates has been a stock item in social psychology as long as anyone can remember. Ordinarily, there is a good crop of both substantive and methodological studies, together with some running debates on issues that stir social psychologists. All these ingredients were present in the 1958 to 1959 literature, but in smaller than usual quantities. In fact, one could say that comparatively little fundamental work appeared, although several pieces deserve more than casual attention.

Problems of method.—In his address to the American Psychological Association on the occasion of receiving a Distinguished Scientific Contribution award, Hovland (54) presented an excellent analysis of the difference between experimental and survey studies of attitude change and suggested that these two types of studies often show different outcomes because of differences in the communication situation (especially audience self-selection), the type of communicator, and kind of issue studied. He takes a balanced position on the issue of realism vs. rigor in design, recognizing the inherent difficulty of creating full-scale realism in the laboratory. Hence, he suggested "the continued use of small-scale experiments which seek to isolate some of the key variables operative in complex situations."

Segall (116) conducted a very carefully designed experiment on the classical problem of determining the scale position of statements to be used in an attitude scale. Following the earlier work of Helson (47) and of Hovland

& Sherif (56) Segall examined the Thurstonian assumption of the independence of attitude and judgment finding that experimentally manipulated experience led to the displacement of judgments. His discussion of judgment and adaptation-level theory examines three possible interpretations of his findings: commitment, assimilation to context, and primacy. He weighs the evidence for each of these explanations carefully, but, justifiably, arrives at no conclusion.

Formation and change of attitudes.—There were several attempts to examine attitude formation through classical conditioning techniques. Staats & Staats (122) demonstrated that they could condition attitudes toward socially significant verbal stimuli—i.e., nationality names and familiar masculine names. Two further experiments in the same vein are reported by Rhine (105), who also argues that attitudes are learned as concepts are. An extension of classical conditioning technique to the area of attitude change appears in an experiment by Rhine & Silun (106), who conditioned attitudes toward unfamiliar social objects, showed that the attitudes generalized, and that the strength of attitude was a function of the consistency of reinforcement. The authors then tested resistance to change and found that subjects receiving greatest consistency of reinforcement showed least resistance to change.

Jones & Kohler (65) reported an experiment and its replication that examined the ease with which a subject learns arguments that favor or oppose his position on an issue. They found that the direction of the argument interacted both with the subject's position and the plausibility of the argument. Thus, prosegregation subjects learned plausible prostatements and implausible antistatements better than they learned implausible pro and plausible antistatements. Neutrals learned all types of statements equally well. Jones & Kohler conclude that individuals attempt to protect an attitude position by denying both implausible elements in their own beliefs and plausible elements in opposed beliefs. This conclusion seems plausible.

Less clear-cut findings were obtained by Peak & Morrison (97), who studied the relationship between position on an issue and the amount of information known about it, as well as the acceptance of new information. They obtained some support for the conclusion that acceptance of information is related to compatibility between previously held attitude and the content of a communication, but that knowledge, as such, is not so related.

Attitudes toward minority groups.—DeFleur & Westie (27) devised a new technique for an old problem: the question of the relationship between verbally expressed attitude and overt action. Using two carefully matched groups of white males and females who had scored either highly rejective or least rejective on a verbal scale of attitude toward Negroes, these investigators asked each subject if he (or she) would be willing to pose for a photograph with a Negro of the opposite sex. Subjects were given a "standard release agreement" to sign on which they could indicate which of a graded series of

uses of the pictures they would permit (ranging from laboratory experimentation to publication in a nationwide campaign advocating racial integration). The results show fair consistency between expressed attitude and use the subject will permit. There are a number of exceptions, however, and the investigators suggest that these subjects may either have been misclassified by the verbal test or, more likely, be involved in a system of social constraints that prevented them from acting overtly in the direction of their convictions.

In another experiment that takes a fresh look at an old problem, Cowen, Landes & Schaet (22) present evidence in support of the scapegoat theory of prejudice. Taft (127) suggests that extremely intolerant subjects and extremely tolerant subjects resemble each other on the Rosenzweig and Bernreuter tests of personality more than either group resembles subjects who are intermediate in tolerance.

A third classic problem in the prejudice area has been the question of whether prejudiced individuals are more skillful at identifying the objects of their prejudice than are nonprejudiced. The complementary argument asserts that those groups that are most easily identifiable are most likely to be objects of prejudice. Both of these arguments were examined in a study by Cooper (21), who showed that attitude toward a particular group is related to (claimed) ability to recognize members of that group. Subjects tended to claim relatively high ability to recognize members of those groups toward which they felt antipathetic and low ability to recognize members of those groups towards which they felt more positive. But subjects who were very high in ethnocentrism claimed ability to recognize members of groups they both liked and disliked more easily than subjects who were low in this attribute. Somewhat along the same lines, Scodel (114) reports a slight tendency for Jewish college students who feel little identified with Jews to identify more photographs as Jewish than do either highly identified or ambivalently identified Jews. He reports however that there were no differences among the groups in accuracy of judgments.

Savitz & Tomasson (110) added a further empirical investigation to the literature on identifiability of Jews, although they did not concern themselves with antisemitism. Like most of the earlier investigations, this one found that Jewish students were correctly identified more frequently than chance expectation. Unlike many earlier studies, the judges observed actual subjects, not photographs, but the conditions of observation were so poorly controlled that one is inclined to discount the authors' claim that multiple cues (appearance, speech, and gesture) were less valid than appearance alone.

Persuasion and attitude change.—One of the perpetually interesting problems in social psychology is the relationship between personality characteristics and persuasibility. McClintock (76) observed that "other-directed" subjects responded differently to various types of persuasive messages than did "ego-defensive" subjects. The more other-directed a subject was, the

more responsive she was to an "informational" communication that put pressure on her to conform to a presumed group norm. Moderately ego-defensive subjects responded best to "interpretative" messages, which explained the psychodynamics of projection. Goldstein (42) divided his subjects into "copers" and "avoiders," a distinction that is roughly equivalent to that between vigilance and defense, and presented them with both strong and weak fear appeals. The analysis, in terms of second order net effects, shows a barely significant tendency on the part of "avoiders" to respond much more to weak rather than to strong fear appeals.

Two experiments examined the effect of providing labels or anchor points to describe the extremeness of a communication on its effectiveness in shaping opinion. Weiss (134) found that labeling a communication as extreme tended to inhibit the amount of change it produced. Incidentally, he found that, the more change advocated, the more relative change was obtained, contrary to the earlier results of Hovland & Pritzker (55). DiVesta & Bossart (31) report that experimenter's labeling of a situation as "ethical" or "economic" affects the extent to which respondents agree with the action taken by one of the principals in the situation.

Authoritarianism and its correlates.—While the debate over authoritarianism and acquiescence has not died, it is waning. Chapman & Bock (17) have presented a method for calculating the amount of variance in F-scale responses that can be attributed to acquiescence set. Jackson (58) has investigated the relationship between acquiescence and coping with perceptual field forces. Jackson's results indicated that acquiescent subjects on the F scale were not able to maintain one perspective on the reversible cube for as long a span, on the average, as those who tended to disagree with F-scale items. Jackson argues that agreement with F scale may be assumed to represent a generalized tendency to conform to field forces.

Leaving acquiescence aside, other investigators have found that authoritarianism differentiates projective responses to frustrating situations. Using pictures of situations akin to those of the Rosenzweig P-F test, Roberts & Jessor (108) found that high authoritarians are more extrapunitive, more personally punitive, and less impunitive toward low-status frustrators than are low authoritarians, while low authoritarians are more personally punitive and less impunitive toward high status frustrators than are high authoritarians. These results correspond closely to those obtained by Thibaut & Riecken (130) in an earlier experiment employing a behavioral test of response to aggressive communication.

Finally, a scale of world-mindedness that differentiates individuals who have high interest in international affairs from those without such interest was reported by Smith & Rosen (121). This study repeated (with modifications) the testing and interviewing procedures of the original California study, finding many of the same differences between highs and lows. The world-mindedness scale turns out to be closely and inversely related to the F scale.

A CROSS-SECTIONAL PERSPECTIVE

It is fitting to end this review of social psychology by reporting that an old acquaintance has returned from a face-lifting operation. The widely used book of readings first sponsored by the Society for the Psychological Study of Social Issues in 1947 has now appeared in its second revision, this time edited by Maccoby, Newcomb & Hartley (78). As in the two earlier editions, reports of empirical research are most emphasized, while theoretical articles and integrative reviews are few. The latest edition has 62 articles, about half of which are new since the second edition in 1952. The new articles are distributed among a dozen categories but the admixture is greatest in the areas of socialization, social stratification, communication, opinion change, and perception of persons. Relatively little new work appears in the sections on intergroup tension and prejudice, reference groups, and interpersonal influence. To be sure, this allocation does not necessarily mirror the present state of social psychology, for the *Readings* are intended for undergraduates and avoid highly technical and specialized work.

Nevertheless, the contents of the *Readings* as well as the perusal of the journals, books, and monographs this year suggest some generalizations. In recent years there have been two lines of growth in social psychology: toward a more precise laboratory science, and toward a more competent understanding of human behavior in the market place. Both kinds of growth are essential for a healthy discipline, and both kinds occurred this year, but social psychologists are increasingly moving away from naturalistic settings and uncontrollable variance. They are not less concerned with the complexity of social behavior but are more than ever interested in precision of measurement and accuracy of explanation. Finally, they are refining and complicating their laboratory procedures, trying, in effect, to study miniature social situations which incorporate significant features of everyday events, but features selected in accordance with some theoretical plan. In short, in the majority of investigations this year, the emphasis was on the scientific significance rather than the practical importance of the results.

BIBLIOGRAPHY

1. Asch, S. E. *Social Psychology* (Prentice-Hall, Inc., New York, N. Y., 646 pp., 1952)
2. Barnlund, D. C. A comparative study of individual, majority, and group judgment. *J. Abnormal Social Psychol.*, **58**, 55-60 (1959)
3. Bass, B. M., Pryor, M. W., Gaier, E. L., and Flint, A. W. Interacting effects of control, motivation, group practice, and problem difficulty on attempted leadership. *J. Abnormal Social Psychol.*, **56**, 352-58 (1958)
4. Beck, D. F. The dynamics of group psychotherapy as seen by a sociologist. *Sociometry*, **21**, Part I, 98-128; Part II, 180-97 (1958)
5. Berkowitz, L., and Howard, R. C. Reactions to opinion deviates as affected by affiliation need (n) and group member interdependence. *Sociometry*, **22**, 81-91 (1959)
6. Berkun, M., and Meeland, T. Sociometric effects of race and of combat performance. *Sociometry*, **21**, 145-49 (1958)
7. Biesheuvel, S. Methodology in the study of attitudes of Africans. *J. Social Psychol.*, **47**, 169-84 (1958)
8. Bjerstedt, A. A field-force model as a basis for predictions of social behavior. *Human Relations*, **11**, 331-40 (1958)
9. Borg, W. R. The behavior of emergent and designated leaders in situational tests. *Sociometry*, **20**, 95-104 (1957)
10. Borgatta, E. F., Cottrell, L. S. Jr., and Mann, J. H. The spectrum of individual interaction characteristics: an inter-dimensional analysis. *Psychol. Repts.*, Monograph Suppl. **4**, 319 pp. (1958)
11. Bugental, D. E., and Lehner, G. F. J. Accuracy of self-perception and group-perception as related to two leadership roles. *J. Abnormal Social Psychol.*, **56**, 396-98 (1958)
12. Burdick, H. A., and Burnes, A. J. A test of "strain toward symmetry" theories. *J. Abnormal Social Psychol.*, **57**, 367-70 (1958)
13. Caplow, T. Further development of a theory of coalitions in the triad. *Am. J. Sociol.*, **64**, 488-93 (1959)
14. Carter, L. F. Recording and evaluating the performance of individuals as members of small groups. *Personnel Psychol.*, **7**, 477-84 (1954)
15. Cartwright, D., Ed. *Studies in Social Power* (Institute for Social Research, University of Michigan, Ann Arbor, Mich., 225 pp., 1959)
16. Cartwright, D., and Harary, F. Structural balance: a generalization of Heider's theory. *Psychol. Rev.*, **63**, 277-92 (1956)
17. Chapman, L. J., and Bock, R. D. Components of variance due to acquiescence and content in the F scale measure of authoritarianism. *Psychol. Bull.*, **22**, 328-33 (1958)
- 17a. Chapple, E. D., and Arensberg, C. M. Measuring human relations: an introduction to the study of the interaction of individuals. *Genet. Psychol. Monographs*, **22**, 3-147 (1940)
18. Cohen, A. R., Brehm, J. W., and Latané, B. Choice of strategy and voluntary exposure to information under public and private conditions. *J. Personality*, **27**, 63-73 (1959)
19. Coleman, J. F., Blake, R. R., and Mouton, J. S. Task difficulty and conformity pressures. *J. Abnormal Social Psychol.*, **57**, 120-22 (1958)

20. Coleman, J. S. Relational analysis: the study of social organizations with survey methods. *Human Organization*, **17**, (4) 28-36 (1958-59)
21. Cooper, J. B. Prejudicial attitudes and the identification of their stimulus objects: a phenomenological approach. *J. Social Psychol.*, **48**, 15-23 (1958)
22. Cowen, E. L., Landes, J., and Schaet, D. E. The effects of mild frustration on the expression of prejudiced attitudes. *J. Abnormal Social Psychol.*, **58**, 33-38 (1959)
23. Cox, J. A., and Krumboltz, J. D. Racial bias in peer ratings of basic airmen. *Sociometry*, **21**, 292-99 (1958)
24. Danziger, K. Children's earliest conceptions of economic relationships (Australia). *J. Social Psychol.*, **47**, 231-40 (1958)
25. Danziger, K. Self-interpretations of group differences in values (Natal, South Africa). *J. Social Psychol.*, **47**, 317-25 (1958)
26. Danziger, K. Value differences among South African students. *J. Abnormal Social Psychol.*, **57**, 339-46 (1958)
27. DeFleur, M. L., and Westie, F. R. Verbal attitudes and overt acts: an experiment on the salience of attitudes. *Am. Sociol. Rev.*, **23**, 667-73 (1958)
28. Deutsch, M. Some factors affecting membership motivation and achievement motivation in a group. *Human Relations*, **12**, 81-95 (1959)
29. DeVos, G., and Miner, H. Algerian culture and personality in change. *Sociometry*, **21**, 255-68 (1958)
30. Dinitz, S., Mangus, A. R., and Pasamanick, B. Integration and conflict in self-other conceptions as factors in mental illness. *Sociometry*, **22**, 44-55 (1959)
31. DiVesta, F. J., and Bossart, P. The effect of sets induced by labelling on the modification of attitudes. *J. Personality*, **26**, 378-87 (1958)
32. Downing, J. Cohesiveness, perception and values. *Human Relations*, **11**, 157-66 (1958)
33. Downs, J. F. Environment, communication and status change aboard an American aircraft carrier. *Human Organization*, **17**, (3) 14-19 (1958)
34. Faunce, W. A. Automation in the automobile industry; some consequences for in-plant social structure. *Am. Sociol. Rev.*, **23**, 401-7 (1958)
35. Festinger, L. *A Theory of Cognitive Dissonance* (Row, Peterson & Company, Evanston, Ill., 291 pp., (1957)
36. Festinger, L., and Carlsmith, J. M. Cognitive consequences of forced compliance. *J. Abnormal Social Psychol.*, **58**, 203-10 (1959)
37. Fiedler, F. E. *Leadership Attitudes and Group Effectiveness* (University of Illinois Press, Urbana, Ill., 69 pp., 1958)
38. Foa, U. G. The contiguity principle in the structure of interpersonal relations. *Human Relations*, **11**, 229-38 (1958)
39. Gerard, H. B. Some effects of involvement upon evaluation. *J. Abnormal Social Psychol.*, **57**, 118-28 (1958)
40. Ghiselli, E. E., and Lodahl, T. M. Patterns of managerial traits and group effectiveness. *J. Abnormal Social Psychol.*, **57**, 61-66 (1958)
41. Goldberg, S. C., and Lubin, A. Influence as a function of perceived judgment error. *Human Relations*, **11**, 275-80 (1958)
42. Goldstein, M. J. The relationship between coping and avoiding behavior and response to fear-arousing propaganda. *J. Abnormal Social Psychol.*, **58**, 247-52 (1959)

43. Gollin, E. S. Organizational characteristics of social judgment: a developmental investigation. *J. Personality*, **26**, 139-53 (1958)
44. Guze, S. B., and Mensh, I. N. An analysis of some features of the interview with the interaction chronograph. *J. Abnormal Social Psychol.*, **58**, 269-71 (1959)
45. Harary, F. Status and contrastatus. *Sociometry*, **22**, 23-43 (1959)
46. Heider, F. *The Psychology of Interpersonal Relations* (John Wiley & Sons, Inc., New York, N. Y., 322 pp., 1958)
47. Helson, H. Adaptation-level as a basis for a quantitative theory of frames of reference. *Psychol. Rev.*, **55**, 297-313 (1948)
48. Helson, H., Blake, R. R., and Mouton, J. S. Petition-signing as adjustment to situational and personal factors. *J. Social Psychol.*, **48**, 3-10 (1958)
49. Hoffman, L. R. Homogeneity of member personality and its effect on group problem-solving. *J. Abnormal Social Psychol.*, **58**, 27-32 (1959)
50. Hoffman, L. R. Similarity of personality: a basis for interpersonal attraction? *Sociometry*, **21**, 300-8 (1958)
51. Hollander, E. P. Conformity, status and idiosyncrasy credit. *Psychol. Rev.*, **65**, 117-27 (1958)
52. Hollingshead, A. B., and Redlich, F. C. *Social Class and Mental Illness* (John Wiley & Sons, Inc., New York, N. Y., 442 pp., 1958)
53. Homans, G. C. Social behavior as exchange. *Am. J. Sociol.*, **63**, 597-606 (1958)
54. Hovland, C. I. Reconciling conflicting results derived from experiments and survey studies of attitude change. *Am. Psychologist*, **14**, 8-17 (1959)
55. Hovland, C. I., and Pritzker, H. A. Extent of opinion change as a function of amount of change advocated. *J. Abnormal Social Psychol.*, **54**, 257-61 (1957)
56. Hovland, C. I., and Sherif, M. Judgmental phenomena and scales of attitude measurement: item displacement in Thurstone scales. *J. Abnormal Social Psychol.*, **47**, 822-32 (1952)
57. Howard, R. C., and Berkowitz, L. Reactions to the evaluators of one's performance. *J. Personality*, **26**, 494-507 (1958)
58. Jackson, D. N. Cognitive energy level, acquiescence and authoritarianism. *J. Social Psychol.*, **49**, 65-69 (1959)
59. Jackson, J. M. A space for conceptualizing person-group relationships. *Human Relations*, **12**, 3-15 (1959)
60. Jackson, J. M. and Saltzstein, H. D. The effect of person-group relationships on conformity processes. *J. Abnormal Social Psychol.*, **57**, 17-24 (1958)
61. Jahoda, G. Child animism: I. A critical survey of cross-cultural research. *J. Social Psychol.*, **47**, 197-212 (1958)
62. Jahoda, G. Child animism: II. A study in West Africa. *J. Social Psychol.*, **47**, 213-22 (1958)
63. Jahoda, G. Immanent justice among West African children. *J. Social Psychol.*, **47**, 241-48 (1958)
64. Jones, E. E., and deCharms, R. The organizing function of interaction roles in person perception. *J. Abnormal Social Psychol.*, **57**, 155-64 (1958)
65. Jones, E. E., and Kohler, R. The effects of plausibility on the learning of controversial statements. *J. Abnormal Social Psychol.*, **57**, 315-20 (1958)
66. Jones, E. E., Wells, H. H., and Torrey, J. Some effects of feedback from the experimenter on conformity behavior. *J. Abnormal Social Psychol.*, **57**, 207-13 (1958)

67. Kates, S. L., and Mahone, C. H. Effective group participation and group norms. *J. Social Psychol.*, **48**, 211-16 (1958)
68. Kelley, H. H., and Thibaut, J. W. Experimental studies of group problem solving and process. In *Handbook of Social Psychology*, Chap. 21, 735-85 (Lindzey, G., Ed., Addison-Wesley Publishing Company, Inc., Cambridge, Mass., 1226 pp., 1954)
69. Kipnis, D. The effects of leadership style and leadership power upon the inducement of an attitude change. *J. Abnormal Social Psychol.*, **57**, 173-80 (1958)
70. Klett, J. C., and Yaukey, D. W. A cross-cultural comparison of judgments of social desirability. *J. Social Psychol.*, **49**, 19-26 (1959)
71. Knapen, M. T. Some results of an inquiry into the influence of child-training practices on the development of personality in a Bacongo society (Belgian Congo). *J. Social Psychol.*, **47**, 223-29 (1958)
72. Levinson, D. J. Role, personality, and social structure in the organizational setting. *J. Abnormal Social Psychol.*, **58**, 170-80 (1959)
73. Lorge, I., Fox, D., Davitz, J., and Brenner, M. A survey of studies contrasting the quality of group performance and individual performance, 1920-1957. *Psychol. Bull.*, **55**, 337-72 (1958)
74. Lövaas, O. I. Social desirability ratings of personality variables by Norwegian and American college students. *J. Abnormal Social Psychol.*, **57**, 124-25 (1958)
75. Lundy, R. M. Self perceptions regarding masculinity-femininity and descriptions of same and opposite sex sociometric choices. *Sociometry*, **21**, 238-46 (1958)
76. McClintock, C. G. Personality syndromes and attitude change. *J. Personality*, **26**, 479-93 (1958)
77. McClintock, C. G., and Davis, J. Changes in the attribute of "nationality" in the self-percept of the "stranger." *J. Social Psychol.*, **48**, 183-93 (1958)
78. Maccoby, E. E., Newcomb, T. M., and Hartley, E. L., Eds. *Readings in Social Psychology* (Henry Holt & Co., Inc., New York, N. Y., 674 pp., 1958)
79. McDavid, J., Jr. Personality and situational determinants of conformity. *J. Abnormal Social Psychol.*, **58**, 241-46 (1959)
80. McPartland, T. S., and Cumming, J. H. Self-conception, social class and mental health. *Human Organization*, **17** (3), 24-29 (1958)
81. Mann, J. H. The influence of racial prejudice on sociometric choices and perceptions. *Sociometry*, **21**, 150-58 (1958)
82. Mann, J. H. The influence of racial group composition on sociometric choices and perceptions. *J. Social Psychol.*, **48**, 137-46 (1958)
83. Matarazzo, R. G., Matarazzo, J. D., Saslow, G., and Phillips, J. S. Psychological test and organismic correlates of interview interaction patterns. *J. Abnormal Social Psychol.*, **56**, 329-38 (1958)
84. Merton, R. K., Broom, L., and Cottrell, L. S., Jr. *Sociology Today* (Basic Books, Inc., New York, N. Y., 623 pp., 1959)
85. Miller, F. B. "Situational" interactions—a worthwhile concept? *Human Organization*, **17**, (4) 37-47 (1958-59)
86. Mills, J. Changes in moral attitudes following temptation. *J. Personality*, **26**, 517-31 (1958)

87. Mills, T. M. Some hypotheses on small groups from Simmel. *Am. J. Sociol.*, **63**, 642-50 (1958)
88. Mills, T. M., et al. *Group Structure and the Newcomer: An Experimental Study of Group Expansion (Studies in Society, No. 1)* (Oslo University Press, Oslo, Norway, 1957)
89. Mischel, W. The effect of the commitment situation on the generalization of expectancies. *J. Personality*, **26**, 508-16 (1958)
90. Morrisette, J. O. An experimental study of the theory of structural balance. *Human Relations*, **11**, 239-54 (1958)
91. Muraskin, J., and Iverson, M. A. Social expectancy as a function of judged social distance. *J. Social Psychol.*, **48**, 11-14 (1958)
92. Murray, E. J., and Cohen, M. Mental illness, milieu therapy, and social organization in ward groups. *J. Abnormal Social Psychol.*, **58**, 48-54 (1959)
93. Nakamura, C. Y. Conformity and problem solving. *J. Abnormal Social Psychol.*, **56**, 315-20 (1958)
94. Newcomb, T. M. An approach to the study of communicative acts. *Psychol. Rev.*, **60**, 393-404 (1953)
95. Palmore, E., Lennard, H. L., and Hendin, N. Similarities of therapist and patient verbal behavior in psychotherapy. *Sociometry*, **22**, 12-22 (1959)
96. Parker, S. Leadership patterns in a psychiatric ward. *Human Relations*, **11**, 287-301 (1958)
97. Peak, H., and Morrison, H. W. The acceptance of information into attitude structure. *J. Abnormal Social Psychol.*, **57**, 127-35 (1958)
98. Pepinsky, P. N., Hemphill, J. K., and Shevitz, R. N. Attempts to lead, group productivity, and morale under conditions of acceptance and rejection. *J. Abnormal Social Psychol.*, **57**, 47-54 (1958)
99. Pryer, M. W., and Bass, B. M. Some effects of feedback on behavior in groups. *Sociometry*, **22**, 56-63 (1959)
100. Rabin, A. I. Comparison of American and Israeli children by means of a sentence completion technique. *J. Social Psychol.*, **49**, 3-12 (1959)
101. Rath, R., and Das, J. P. Study in stereotypes of college freshmen and service holders in Orissa, India, toward themselves and four other foreign nationalities. *J. Social Psychol.*, **47**, 373-85 (1958)
102. Raven, B. H. Social influence on opinions and the communication of related content. *J. Abnormal Social Psychol.*, **58**, 119-28 (1959)
103. Raven, B. H., and French, J. R. P., Jr. Group support, legitimate power and social influence. *J. Personality*, **26**, 400-9 (1958)
104. Raven, B. H., and French, J. R. P., Jr. Legitimate power, coercive power and observability in social influence. *Sociometry*, **21**, 83-97 (1958)
105. Rhine, R. J. A concept-formation approach to attitude acquisition. *Psychol. Rev.*, **65**, 362-70 (1958)
106. Rhine, R. J., and Silun, B. A. Acquisition and change of a concept attitude as a function of consistency of reinforcement. *J. Exptl. Psychol.*, **55**, 524-29 (1958)
107. Riecken, H. W. The effect of talkativeness on ability to influence group solutions to a problem. *Sociometry*, **21**, 309-21 (1958)
108. Roberts, A. H., and Jessor, R. Authoritarianism, punitiveness, and perceived social status. *J. Abnormal Social Psychol.*, **56**, 311-14 (1958)

109. Rosenberg, S., and Hall, R. L. The effects of different social feedback conditions upon performance in dyadic teams. *J. Abnormal Social Psychol.*, **57**, 271-77 (1958)
110. Savitz, L. D., and Tomasson, R. F. The identifiability of Jews. *Am. J. Sociol.*, **64**, 468-75 (1959)
111. Schachter, S. *The Psychology of Affiliation* (Stanford University Press, Stanford, Calif., 141 pp., 1959)
112. Schroder, H. M., and Hunt, D. E. Dispositional effects upon conformity at different levels of discrepancy. *J. Personality*, **26**, 243-58 (1958)
113. Schutz, W. C. *FIRO: A Three-dimensional Theory of Interpersonal Behavior* (Rinehart & Co., Inc., New York, N. Y., 267 pp., 1958)
114. Scodel, A. Some correlates of different degrees of Jewish identification in Jewish college students. *J. Social Psychol.*, **49**, 87-94 (1959)
115. Seeman, M. Social mobility and administrative behavior. *Am. Sociol. Rev.*, **23**, 633-42 (1958)
116. Segall, M. H. The effect of attitude and experience on judgments of controversial statements. *J. Abnormal Social Psychol.*, **58**, 61-68 (1959)
117. Shaw, M. E. Some motivational factors in cooperation and competition. *J. Personality*, **26**, 155-69 (1958)
118. Slater, P. E. Contrasting correlates of group size. *Sociometry*, **21**, 129-39 (1958)
119. Smith, A. J. Perceived similarity and the projection of similarity: the influence of valence. *J. Abnormal Social Psychol.*, **57**, 376-79 (1958)
120. Smith, E. E. Individual versus group goal conflict. *J. Abnormal Social Psychol.*, **58**, 134-37 (1959)
121. Smith, H. P., and Rosen, E. W. Some psychological correlates of worldmindedness and authoritarianism. *J. Personality*, **26**, 170-83 (1958)
122. Staats, A. W., and Staats, C. K. Attitudes established by classical conditioning. *J. Abnormal Social Psychol.*, **57**, 37-40 (1958)
123. Steiner, I. D., and Peters, S. C. Conformity and the A-B-X model. *J. Personality*, **26**, 229-71 (1958)
124. Stock, D., Whitman, R. M., and Lieberman, M. A. The deviant member in therapy groups. *Human Relations*, **11**, 341-72 (1958)
125. Stotland, E. Determinants of attraction to groups. *J. Social Psychol.*, **49**, 71-80 (1959)
126. Strickland, L. H. Surveillance and trust. *J. Personality*, **26**, 200-15 (1958)
127. Taft, R. Is the tolerant personality type the opposite of the intolerant? *J. Social Psychol.*, **47**, 397-405 (1958)
128. Tagiuri, R., and Petrullo, L., Eds. *Person Perception and Interpersonal Behavior* (Stanford University Press, Stanford, Calif., 390 pp., 1958)
129. Talland, G. A. Sex differences in self assessment. *J. Social Psychol.*, **48**, 25-35 (1958)
130. Thibaut, J. W., and Riecken, H. W. Authoritarianism, status, and the communication of aggression. *Human Relations*, **8**, 95-120 (1955)
131. Tupes, E. C., Carp, A., and Borg, W. R. Performance in role-playing situations as related to leadership and personality measures. *Sociometry*, **21**, 165-79 (1958)

132. Videbeck, R., and Bates, A. P. An experimental study of conformity to role expectations. *Sociometry*, **22**, 1-11 (1959)
133. Watson, J. A formal analysis of sociable interaction. *Sociometry*, **21**, 269-80 (1958)
134. Weiss, W. The relationship between judgments of a communicator's position and extent of opinion change. *J. Abnormal Social Psychol.*, **56**, 380-84 (1958)
135. Zaidi, S. M., and Ahmed, M. National stereotypes of university students in East Pakistan. *J. Social Psychol.*, **47**, 387-95 (1958)
136. Zander, A. Group membership and individual security. *Human Relations*, **11**, 99-111 (1958)
137. Ziller, R. C., and Exline, R. V. Some consequences of age heterogeneity in decision-making groups. *Sociometry*, **21**, 198-211 (1958)

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